THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXX. FEBRUARY, 1906. No. 5.

THE AMERICAN, AND THE GERMAN, "PERIL."

By Louis J. Magee.

II. DIFFERENCES IN NATIONAL TRAITS AND INDUSTRIAL POLICY.

Mr. Magee's peculiar command of his topic—his intimate friendly comprehension of German industrial life and his loyal Americanism—were pointed out in his introduction last month. The present paper deals with matters which lie at the foundation of Germany's national ascendency.—THE EDITORS.

WERE this an attempt to draw up an international balance-sheet, we should not have much difficulty in finding some virtue to offset each disagreeable liability. In the young civilization of America one could point to intellectual triumphs of which maturer lands might well be proud. On the records even of Germany's financial life one could find some scandals; exceptions, compensations on every hand. This is however rather an appeal to Americans to study Germans as they study us. The true picture of Americanism is gradually developing before European eyes. What matter if at first some of our high-lights create a misleading effect?

Each visitor from Europe imagines that he has discovered his own fine *nuances* in the characterization of the American people and methods. One of them recently gave it as his opinion that the high standard of effort in American factories and offices was due to the fact that the rank and file of the workers were not accustomed to alcoholic stimulants.

Another keen German observer, in reality a great admirer of America, laughs at our national fondness for dimension. He says that it is almost impossible for an American to describe anything without some statement as to comparative measurements. A railroad is "the longest in the world," or hauls the "greatest number of tons of coal"; a water-fall is the "highest in the world." We must always

speak of the highest building, the largest capital, the wealthiest man, the "greatest show on Earth," etc.

A cultivated banker, upon returning to Berlin, said to his associates:

"I was touched by the exceptional kindness of most of the Americans whom I met. They seemed so very trustworthy, and displayed a frankness in all business affairs that I have never known elsewhere. The optimism of the American is universal. I hunted 'with a lantern' for a pessimist, but found none.

"The business of prophets (clairvoyants, astrologers, palm readers, etc.) flourishes as in no other country. Some of the most beautiful churches belong to Faith Curists. The quality of the plays in the theater is, in general, of so low an order that they do not offer any intellectual charm to the European."*

The younger men who come over are carried off their feet by our outward signs of prosperity; by our business rush and our sublime recklessness in forging ahead for results without quibbling over means. They laugh at any crudeness and disorder as unimportant compared with ultimate attainment, because youth cares more for movement and progress than for comfort and solidity.

One of the points frequently noted is the tendency of American industries to make themselves independent in the supply of half-products and raw stuffs; as brought out, for instance, in the ownership by the U. S. Steel Corporation, of mines, steamers, and railways. The Germans are always astounded to find so many young men in positions of the highest responsibility in the United States. The gravest difficulty that capitalists have had during the recent years of German industrial activity, is to find the suitable men to take charge of great enterprises. The Government service has surrendered a few able men for such positions. Perhaps the most outspoken difference which Germans see between our home market and theirs, is that the greater luxury and higher standards of living in our country add enormously to those demands which would result in any case from the increase of population and general development of resources. Furthermore, the dearness of labor causes us to purchase new products rather than to spend time on the repair of what is only partly worn out.

Scientists abroad are inclined to consider us in advanced physical investigation as more "extensive" than "intensive." In how far the

* "I would desire for my country three things above all others, to supplement our existing American civilization: from Great Britain her administration of criminal justice; from Germany her theater; and from any European country, save Russia, Spain, and Turkey, its government of cities."—*Autobiography of Andrew D. White.*

recent princely additions to our research facilities will better our already respectable record in this regard, it is difficult to forecast. Probably our rapidly improving standards of scholarship will mean more than any material advantages. The most critical element of European culture appreciates and admires much of our scientific work, and we all know that there is a large number of serious workers in our universities and Government bureaux; but, on the other hand, it cannot be controverted that our national impatience and eagerness for results seriously interferes with research in the sense that it is carried on in Europe. Some of our best private workers have been spoiled in a way by sudden prosperity; their productivity has decreased with increasing wealth.

The research organization costs a great deal more to support in America than in Europe, for the reason that the comparatively few trained young scientists in our country get into highly remunerative positions with corporations, whereas in Germany there is a greater supply of trained men. It must not be thought, however, that the European professors are working alone for the love of science. Many of them are getting large incomes by giving expert advice and making practical designs for various branches of industry. But these financially sucessful ones seem still to specialize, and to work persistently, with their increased means, within the limitations of their own subjects.

The best informed and most impassionate German observers believe that we shall always be their sharp competitors, but they see nothing in our industrial development, as compared with their own, to make them "fall on their backs," as they put it. The American danger does not seem imminent, but they are on the look-out. The question naturally suggested by all the present signs of Germany's commercial energy, and the high standard which her industries have set, is whether a *German* danger does not exist.

Explanations for Germany's imposing advance are plentiful in current literature. The good things that especially appeal to one in German life are probably all contributing in a complex way to the present prosperity; but long training and hard work tell most of all, and these characteristics came from a great past. The commercial power which Germany exercised in the Hansa times, did not entirely die out. The merchant houses of Hamburg, Bremen, and Lübeck, and the bankers of the inland towns, have, for centuries, kept up their traditions and remained in touch with the rest of the world. The closer union of German States into a peaceful and well governed empire was needed further to encourage the business enterprise and energy which was

lying dormant. First therefore comes the merchant; then the engineer. The business of the future will probably depend more and more upon the engineer. As education becomes more general and theory more exact, the production of new articles of commerce will depend to an increasing extent upon engineering knowledge. All the problems which come up in railroading, mining, and factory operation will require still better engineering for their solution as the number of applicable inventions increases. Germany is especially strong on the engineering side of business. As German firms are in the habit of taking exclusive contracts, their staffs for tenders and construction are large. A manufacturer takes the responsibility for a whole plant, consisting of the most varied elements. Consulting engineers are not numerous in Germany.

There is no question as to the high grade of American engineering. Its boldness too, its ingeniousness, and practicalness, have been among the most characteristic phenomena of our development. American engineers have even won some of their best laurels under the trying conditions of European practice. But these flattering reflections should not blind us to the recognition that much waste of money, danger to life, and misuse of material, might have been avoided if sound training were more widespread among us, and men with at least rudimentary engineering education more plentiful. Our incomparable successes with empirical methods are still leading us into the temptation of relying on experience, and being merely "practical."

America has long led the world in the production of articles in which the interchangeability of parts and ingenious arrangements of mechanical details, combined with solidity, cheapness, and elegance of form are characteristic. The sewing machine, typewriter, and cash register are, perhaps, the best instances. Now it is probable that our factories will always have a fair part of the world's business in such articles. Our marked ingenuity will provide for improvement and novelty. But the last decade, especially, has shown us that the persistence of scientific theoretical workers can produce articles of commerce which can never be evolved by the brightest workman. For instance: the Welsbach mantle and other improvements in lighting have opened up branches which hardly could have developed from previous methods. Financial rewards for research are illustrated most strikingly perhaps by chemical products such as medicines, disinfectants, dyes, and photographic supplies. The German chemical industries are notably progressive and successful. The 143 chemical companies of the Empire, with a working capital of $158,000,000 returned last year an average profit of 9.37 per cent.

If, therefore, the technicist, the engineer, and the laboratory are to become more and more the dominating forces in industrial expansion, educational training becomes, even from a purely commercial standpoint, more essential than ever. Moltke's reputed saying that the Prussian school-master won the battle of Sadowa is still more applicable to the peaceful battles of trade. The great hope of the United States in industry as well as in government, is education. We depend upon it even more than does Germany or England, because we have an ignorant colored, and immigrant, population to deal with. There are now about as many people of the Greco-Latin, Slav, and other "feminine" races (to use Bismarck's expression) in the United States as the total of foreign-born inhabitants half a century ago. The strength of "masculine" Germanic influence cannot remain unaffected by this increasing element.

If we are to obtain any help from a study of Germany, as regards education, we must study the spirit of it and not merely the forms of its organization. The university methods are so generally known as to make any extended mention of these deep well-springs of scientific attainment unnecessary. It is worth while noting that some of the best men in the German industries today, come directly from the universities, and have no technical-school training. That productive scholarship on the part of the professors is immensely helped by leaving much instruction to the *Privatdocenten*, (tutors) is, no doubt, gradually being recognized by American educators.

The ten technical universities of the Empire, (called technical high-schools), enrolling over 17,000 students, are in close touch with, and a great help to, the industries. In several cases they cultivate special branches with regard to local interests. For instance, the school in Dresden, being near a great textile district, has a course for the technics of dyeing. The Aix-la-Chapelle school being so near the coal-fields and iron-works, has especially good courses in mining and metallurgy. Danzig includes marine engineering, of course, though Berlin already stands very high in that department. Karlsruhe has a forestry department; and Munich, an agricultural course.

The latest of these great institutes was opened only a year ago at Danzig. In conversation with some German professors I gained the impression that they had great respect for the American institutes of technology, and had in some cases made use of the superior arrangements of our laboratories as arguments in getting appropriations for the improvement of their own laboratories. Graduates of the best technical institutes in the United States, as seen in the industries, make, as a rule, quite as good an all-round impression as their Ger-

man *confrères.* The former are likely to be more generally well informed and more flexible in their adaptability to a variety of work. A comparative novelty even for Germany is the commercial "high-school," a high-class business institute for instruction in finance, trade, and the business side of industry. The very latest advance in this direction is the *Handels-Hochschule,* commercial "high school," (remembering that this word is equivalent to our "college" or "institute") to be opened next Autumn under the auspices of the Corporation of Berlin merchants. It will receive only those who have had their years of apprenticeship in actual business and who are able to pass the examinations of the "one year service army volunteer." This is the first institute of its kind in Germany at least, to be the independent creation of such a body. The social side of German college and institute life is less healthful than that of America, although nothing in it compares with the occasional unmanly cruelty of our hazing.

It is not, however, so much in these two highest categories of education that we are likely to be surprised in our German observations. but rather in the bewildering list of middle and lower schools. The most wonderful thing about these is their ingenious adaptability to all hours of the day, to all ages, occupations, and grades of preparation. There are for instance scattered through Germany a number of private technical institutes (called *Technicum*) for those whose preparation does not fit them for higher engineering schools; especially for cases in which the earlier years had to be passed in shop work for self-support. Then, too, the cities are establishing new "technical middle-schools." It is everywhere evident that the Germans are no longer satisfied with a few hundreds of famous scholars, a few thousands of professional men—and then a drop almost down to the "three Rs." They are wisely grading off their material. They have many different standards as to what constitutes an educated man. Then they try for ninety-nine per cent efficiency under whatever standard the subject may properly belong. Even housemaids, butlers, and chimney-sweeps may receive in special schools all the correct fundamental preparation for their humble careers. The fact that a boy or girl has left the common schools and taken employment, is by no means an indication that the school days are over; on the contrary, the day's occupation creates interest for the evening courses in the "continuation" schools. In some of the schools charges are made, others are free. Some are supported by the State, some by the city, others by employers' guilds in various branches of business; and others by private funds. Some of the schools receive support from all these sources.

Public libraries offering as they do such a possibility for self-education are by no means as numerous or as well equipped in Germany as they were in many of our States even over a decade ago. Our weekly papers and monthly magazines are also, as the best informed Germans admit, far greater in number, more varied and, as a rule, more interesting than their own. The American periodicals being more widely purchased and read, are able to command a better class of contributors.

There is one great trend, however, that runs through all branches of educational life in Germany and which, according to my observation, explains the efficiency of the German system better than does the existence of this or that kind of school*; I refer to thoroughness of training in the rudiments. We may have in our country many ad-

---

* The variety of opportunities for education will be more apparent if we glance, for instance, at the actual list of Berlin students in the winter of 1903-4.

(a) The Royal University (thirteen per cent. of all non-German students were Americans.)	7,154	Students
(b) The Technical Institute	4,157	"
(c) Mining Academy; Agricultural Institute; Veterinary College; Oriental Language Seminary	2,000	"
(d) Gymnasia, and others, corresponding to our higher grammar, and high, schools and lowest college classes	23,302	Pupils
(e) Common schools	222,472	"
(f) Private lower schools	16,432	"
(g) 4 Municipal night institutes	1,083	"
13 " " continuation schools (among these latter 2,006 business, and 6,981 hand trade, apprentices.) These schools teach German, English, French, machine drawing, lettering, stenography, typewriting, commercial correspondence, bookkeeping and allied branches, sewing-machine work, machine embroidery, tailoring, mending, ironing, cooking, etc.	16,420	"
(h) Various schools; for deaf and dumb, blind, orphans, etc.; also elementary training for Royal Theatre	892	"
(i) Two Municipal night trade schools including day courses for painters, cabinet-makers, modellers in clay and wax, electro-wiremen, etc.	4,979	"
(j) Builders trade	255	"
(k) Weaving school (101 *day* pupils and 239 *Sundays* and evenings)	239	"
(l) Cabinet-makers (1,028 being apprentices)	1,385	"
(m) Specialist schools—for masons, carpenters, saddlers, painters, chimney-sweeps (79 pupils), barbers and hairdressers (540 pupils), glaziers, smiths, basket-makers, book binders, printers, gardeners, photographers, tailors, potters, plumbers, paper-hangers, wagon-makers, etc.	4,903	"
(n) Schools supported by guilds and associations, as, for instance, 6 commercial night schools established by the Corporation of Berlin Merchants; also schools supported by bakers, and coopers	6,084	"
(o) Private institutions for technics, college and military preparation, etc., including schools for house servants, tailors, housekeeping, womens' handiwork, sewing, etc.	4,359	"
Total	316,116	

The above does not include the kindergarten, or schools of art and music.

vanced ideas as to gaining the pupil's attention and interest, leading by love instead of the rod, and increasing powers of observation; but the cold-blooded German schoolmaster seems to succeed in doing such an immense amount of drilling, especially in mathematics and languages, that these branches become useable and are not soon forgotten. Languages as taught in our schools seem to have been considered too much from a literary and analytical standpoint, and it is a rare thing for even a college graduate who has had frequent examinations in French and German to be able to speak a word or understand a paper in these languages until he has learned them over again in Europe. In fact, the German clerks, stenographers, and business men, in general, use their *mother tongue* more grammatically than do Americans under analogous conditions. Even our college boys and school teachers frequently show a lamentable carelessness in this regard. Notwithstanding the high rank of our advanced mathematicians and astronomers, mathematics seem to be much more of a stumbling block for us as a nation than for the Europeans. They require immense training rather than great ability. The continued practice, repetition, drill in everything is, therefore, to my mind, first of all, the key-note of German education.

Another element which makes for efficiency in German life and, of course, plays a great rôle in the school routine, is discipline. The average German is certainly not more mentally alert or convincing than an American in an analogous position. But the national attitude of mind is friendly to order, clearness, organization and precision. Germans are taught respect for existing arrangements; the subordination of the member to the body; regard for duly constituted authority as designated in rank and title. This comes somewhat from military *régime*; but long before Germany had a well organized army it had the well organized home. The child's obedience of its father came first of all. The child is not only punished for disobedience, but is trained in a certain code of manners and correctness of formality which, under similar conditions, our children are expected to pick up for themselves. Such training may not prevent the subject from becoming a boor, but it will lay the foundation for system; obedience to the orders of the next above, obedience to the laws. This produces a normal type. It may interfere with individuality, but it does not seem to hurt the intellect or weaken the energies. Carried too far it throttles that daring resourcefulness and independence of decision which is so characteristic of American business men, and which may save a situation where correct procedure

means catastrophe. With us the initiative of the individual in the organization is largely depended upon; with the Germans it is the strength of the machine. With us an appeal to the individual may accomplish wonders. While the *esprit de corps* of American technical staffs, in many of the large firms, is infinitely better than that which you would find in Europe, and while the American business man may be something of an engineer (and a good engineer in America is frequently very much of a business man), and while with these qualities the American can make up for what he lacks in the way of order in his nature, there are many points in industrial organization where a large supply of discipline makes toward efficiency. There may be in Germany a lack of friendly contact between the man and his superior. There is, perhaps, too little personal feeling and too much coldness in everyday business dealings. On the other hand, there seems to be sometimes in America a certain neglect of precision on the part of the officer toward those under him, and a tendency to avoid giving strict orders. Advice and suggestion are often, perhaps wisely, made to take the place of instruction and reprimand. How far we could learn from Germany in tightening the reins a little, is a delicate question.

Germans are however always impressed by the fine appearance of an American industrial staff. The officers, department heads, and engineers make a very imposing group. This is perhaps due to the breadth of our experience, or education, and to the fact that the officers of American companies treat their assistants with that consideration above mentioned, which is not the rule in Germany. Furthermore, a German concern has very few highly paid men, but these work as rapidly, as efficiently, and quite as much, I think, as their American *confrères.* The German may, after all, be right in saying that if a poor country like his own is to have any great result from its industries, there is "no time for making compliments." It is a hard grind in which everybody must be exacting and get as much as he can from those under him. The Germans are used to looking truths in the face. The employees of great firms are mostly free from illusions. I think their rather hopeless outlook is going to be dissipated to a certain extent in a few years, when the idea of sport has taken hold of the nation to a greater extent. The very disturbing pause of two hours in the middle of the day during which no other "sport" than eating, drinking, and sleeping can be indulged in, will, in the course of time, give way to the American system. Certain tendencies to irritability and depression will then succumb to the influence of fresh air and exercise. Even fresh air, however, can be-

come a serious disturber of industriousness if indulged in too much. Some observers think that we have a tendency occasionally to drop the end of the day or week from our business calendar in a way that German business at least would not stand, no matter how much good, theoretically, the recreation might accomplish.

Not a little of the credit for German industrial success and power is due to good government at home. The engineer is becoming every year a more important factor in the life of the city and the country. Germany's public technical achievements are worth ten times the study we give them. The men who design and carry out their public works are unassuming experts; masters of their specialties; comparatively little in the public eye; contented with small remuneration. Only a very limited use is made by the daily press of personal notes, portraits and interviews. It thus happens that a German engineer may be exceedingly clever and productive without becoming known outside of his profession. And even the technical press is inclined to be very impersonal. Our national eagerness for personalities, our amusing fondness for "throwing bouquets," probably does have at least the merit of securing for a deserving man a greater breadth of opportunity and a higher general standing than unadvertised efforts alone could bring. In the agitation regarding governmental and municipal ownership of public utilities which, from now on, will certainly be a feature of our political life, the study of German, and not merely English, experience, though not necessarily applicable to our own conditions, will be illuminating.

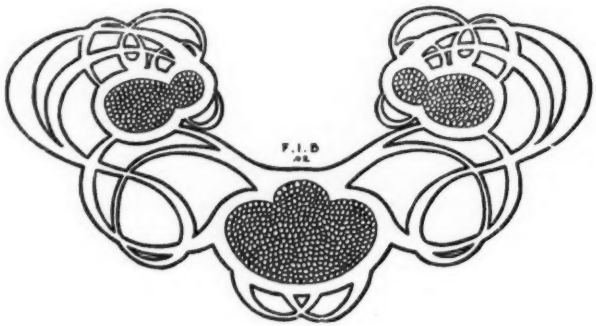
The statement that American railway managers could learn anything from the Germans, will seem like pure heresy. The apparently higher regard for the value of human lives in Germany is dominant in their technical practice. Even some of their arrangements of minor importance might possibly be adopted by us without much discussion; for instance, the use of slot machines for the sale of city and suburban tickets, and for the sale of platform tickets (2½ cents). The discretionary powers given gate-keepers in some of our stations, and in some cases the positive rules against the admission of those accompanying travelers to the train, constitute an annoyance which is incompatible with the liberality of our railways in other particulars. Of course, unfair discrimination in rates and private freight-car abuses do not exist under the German Government system. The Germans consider Government ownership and operation of the railways, while salutary for their own country, entirely unadapted to our present national spirit of order and discipline.

As for municipal ownership, the large socialistic element in Germany has for years worked in this direction. A good basis for municipal ownership existed in the excellent and business-like management of the cities. But despite this fact it is private capital which has within the last few years revolutionized traffic and opened up new districts for settlement. Out of the 2,370 miles of electric roads in Germany, only about 400 miles, or 17 per cent, belong to the municipalities, counties, or States; and some of these even are operated by private companies. Out of 140 centres of electric transportation, only 31, or 22 per cent, have, even in part, municipal roads, and many of the centres included in this list have *more private* than city lines. Hamburg and Leipzig have no municipal lines in operation whatever; Berlin has about ten (unprofitable) miles and is soon to build a few more. When, according to contract, the opportunity came for the city to take over the very successful and highly modernized light and power plants, it failed so to do. The German cities have properly guarded the common interests when awarding franchises and, as a rule, they consider that the present large annual payments to the city made by private corporations, represent as much net profit as could accrue to the citizens on any municipal-ownership basis.

The postal service in Germany is far more satisfactory and reliable than our own. A former postmaster-general, eager to improve his system, and unable to get sufficient capital for buildings, resorted to the idea of enlisting private capital and making long-term contracts of rental. The Government has also built liberally and, in some cases, almost lavishly. The postal department, including the telegraphs, now turns in to the Imperial treasury a net surplus of over $16,000,000 annually. Now that an American postmaster has studied European methods, it is to be hoped that those upon whom he depends for appropriations may be brought to appreciate how much enlarged offices, increased personnel, and new conveniences are needed to serve our rapidly increasing traffic. The German telegraph service, operated entirely by the postal administration, is exceedingly reliable. Ten words, not including the address and signature, can be sent anywhere within the Empire, that is, a maximum distance of about 1,000 miles, for 12½ cents.

There is nothing, however, in Germany to approach the system and rapidity which has developed along with the volume of our Stock Exchange business. The Clearing House, brokers' boards, quotation and news tickers, telephone arrangements and, in fact, the whole

paraphernalia connected with Wall Street is, to the European, a wonderful combination of business cleverness and technical skill. The adaptability of our telegraph and telephone systems to meet special demands could probably never keep pace with the public needs, if placed under Government management. The special terminal facilities and rates which our chief telephone company arranges for firms with long-distance connections, the private wires, the telephoning and telegraphing of election news, etc., are not concessions wrought from an unwilling management, but ingenious ways of pleasing the public and, at the same time, extending the usefulness of our technical means of communication. In Germany the telephone service is also in the hands of the Government. It is managed conscientiously, even liberally, and is really being improved continually; but the machinery of even so surpassingly good a Government does not seem to be adapted to the extension of such a service, in which one must really feel the public pulse. There are not quite four times as many telephones in the Empire as there are in Manhattan and the Bronx. There are few public booths, and no telephones in the hotel rooms which can communicate with the city lines. The telephones used for internal communication between the rooms of an office building are separate from those which connect with the outside world. To one returning from a long residence abroad, the effect which the telephone has had in the last decade in changing the physiognomy of American business and social life is more marked and wonderful than any other single feature of difference between the Old World and the New.



ELECTRIC TRACTION BY ALTERNATING CURRENTS.

By Louis Bell.

Dr. Bell's topic is the most important in electrical engineering at the present time. The heavy installation decided upon by the New Haven road accentuates the interest of this discussion by one of our most instructive modern writers.—THE EDITORS.

BY far the most interesting development in electric traction during the past two years has been the introduction of the alternating-current motor, both in America and Europe. Its appearance was nearly simultaneous in the United States, Italy, and Germany, by methods closely similar. The publication of Dr. Finzi's experiments served to stir up the others who had been working on the problem, and to do justice to the American contingent, its work was probably ahead of the rest. The immediate result has been the equipment of perhaps a dozen roads of the smaller sort, and what is far more sensational, the ordering of alternating current locomotives on a large scale by the New York, New Haven and Hartford Railroad Company. It is this last move that has stirred up the most active discussion in engineering circles.

Now the fundamental question to be asked in the premises is this: "Why should any engineer prefer an alternating-current motor for electric traction when he already has exceedingly good direct-current motors?" And the answer is an exceedingly simple one. Engineers do not prefer the alternating-current motor as such, but because by its means it becomes easy to do certain things which are practically out of the question so long as one adheres to direct current.

The fundamental advantage of alternating current for nearly all purposes lies in the fact that energy in such form can be changed in voltage to any required extent by very simple apparatus at very high efficiency. The alternating-current transformer costs considerably less than half as much as any form of electric generator, and transforms the energy received into energy of different voltage, at a loss of only two to three per cent. Hence, by carrying about a piece of apparatus neither very costly nor very heavy, one can receive from the line energy at very high voltage and deliver it to the motor at whatever lower voltage may be required. The alternating-current motor in itself is not especially suitable for high voltage, but the combination of transformer and motor can not only work on a high-voltage

circuit but on the motor side can be operated with as wide a range of voltage as may seem desirable for the purpose of regulation.

Since the amount of copper required to transmit, let us say, the energy for a car over a given distance, varies inversely as the square of the working voltage, the loss remaining the same, it is clear that to deliver power to a car at 2,500 volts requires only one twenty-fifth as much copper as at 500 volts. In other words, excluding some minor considerations, there is an enormous gain in the cost of delivering energy to the cars if one works at the high voltage used with the alternating-current system. All this has been long understood, and the standard method of working long electric roads today is to distribute the energy at high voltage over the system, and then, since the motors themselves are for direct current, to transform the transmitted energy to direct current and to distribute this to the working conductors from which the motors are fed.

It will at once be seen that this scheme requires two complete distributing systems over practically the whole extent of the road—one to distribute energy at low voltage to the motors, the other to provide at high voltage the energy for feeding the first. The change from high-voltage alternating current to low-voltage direct current is accomplished first by reducing the former through transformers to a voltage even lower than that of the direct current required, and second by changing from alternating to direct current via a rotary converter, which is rather more expensive than an ordinary dynamo and like it requires continuous attendance.

The series of energy transformations in a typical electric-railway case by the two methods respectively is as follows. Present system: —Generator—high-voltage line—reducing transformers—rotary converter—low-voltage line—motor. Alternating system:—Generator, high-voltage line, reducing transformer (on car)—motor. This series omits the two steps which in the former are particularly serious in cost and in loss of energy. The saving in energy alone would in the ordinary case be some 20 or 25 per cent. It needs no argument, therefore, to show that such a change would be in and of itself extremely desirable.

In addition the supply of energy at high voltage from the working contact conductors very greatly simplifies the collection of current by the contact devices. At the customary working voltage of about 600, the current necessary to drive a modern interurban or suburban train amounts to several hundred amperes, a quantity which it is extremely difficult to obtain from an overhead trolley wire without very troublesome sparking and burning at the contacts. Hence many roads have

been driven to the use of the third rail, which is a continual source of danger both to operation and to life, and which is extremely difficult to insulate adequately. At high voltage the necessary current proportionately decreases so that in the Zossen tests of a couple of years ago the heavy cars requiring at the higher speeds an input of 2,000 horse power, received their energy from three slender overhead wires each about the size of a lead pencil. So far as simplicity, efficiency, and cost of the conducting system is concerned, there is everything to gain and nothing to lose in using alternating current.

The rail return circuit undoubtedly has considerably lower virtual conductivity for alternating than for direct current, but this difference is more than offset by the fact that with alternating currents the electrolysis—sometimes very formidable with direct current—is of small moment.

Under these conditions it is not surprising that alternating-current traction has been vigorously pushed, and the sole reason for its relatively small development up to the present time must be sought in the difficulty of designing proper motors. To be sure, there have been a number of successful three-phase roads abroad using induction motors on the cars, of which the best known is the Valtellina line. The fact that a three-phase line requires at least two working conductors has been a serious objection in the eyes of American engineers, mindful of the exasperating early experience with direct-current double-trolley lines. Unquestionably, in urban work with its many crossings, a double-trolley system is a nuisance; but on long interurban lines it is by no means difficult to manage. A more valid reason for wishing to dodge three-phase motors for traction is that they have but a single economical speed—that near synchronism. Speed regulation can be obtained by the use of rheostats on the same terms that are familiar in the rheostatic control of an ordinary direct-current railway motor, but in recent years this has been almost entirely superseded by the more economical series-parallel control, for which no proper equivalent is available in using induction motors. The so-called "cascade" arrangement of induction motors is far inferior to the regular series-parallel connection.

For a general solution of the alternating-current traction problem, then, it has seemed best to turn away, temporarily at least, from the otherwise very attractive induction motor and to take recourse to motor systems capable of being operated from a single alternating-current working conductor. One such system which cannot be passed over without serious consideration is that brought forward some years ago by H. W. Leonard and since somewhat developed experimentally

abroad. It consists of a single-phase high-voltage circuit for the working conductor, feeding a motor-generator or rotary converter on the locomotive, which is in turn provided with motors governed by Mr. Leonard's beautiful regulating system. The scheme gives a far more perfect and delicate speed control than any other yet devised, and an efficiency high compared with that of the usual complicated plan of distribution. It is, however, open to the objection that the equipment required cannot be stowed away under a car, and gives considerable weight to be carried. If the very ingenious "permutator" recently developed abroad should meet the hopes of its friends, the weight situation would be very greatly relieved, and the fact is that for the heavy railway work in which locomotives are desirable the Leonard system has some extremely strong points which it is not the part of wisdom to overlook.

But for the ordinary routine work of electric railways it has been necessary to turn to an entirely different type of machine—the single-phase commutating motor. This machine is based on the simple fact that a series-wound direct-current motor does not change its direction of rotation if the current through it is reversed, but only if the relative direction in armature and field is reversed. Hence such a motor will work on a circuit in which the current periodically reverses direction if the conditions are not too severe. The requirements for success are lamination of the field magnet as well as the armature, in order to prevent great loss of energy from eddy currents; very low inductance, so as to allow the passage of heavy alternating currents without causing serious inductive troubles in the system; and finally, extraordinary care in the design of the commutator to prevent destructive sparking.

The first requirement is easily met, at the cost of considerable expense but at a gain in the weight of the motor owing to the use of better iron more judiciously distributed.

The second is met, first by very tactful design of the motor windings for low inductance, the result being a large and powerful armature in a field with relatively simple winding; and next, by the use of so-called compensating coils cross-magnetizing the armature and greatly reducing the virtual inductance. These are connected in various ways, but the effect is always to oppose by a reverse magnetomotive force those components of magnetization that would cause troublesome inductance. It is needless here to go into the details of the various forms taken by the compensating winding, and it is sufficient to state that they have proved highly effective.

Finally, the commutation of an alternating-current is a very

troublesome matter, owing to the fact that there is generally no instant at which commutation can occur without either breaking a considerable current or leaving considerable electro-motive force between bars. The heavy inductive effects tend strongly to produce sparking or even flashing over the commutator surface, and it is not putting the case too strongly to say that successful commutation is the vital point in developing a successful single-phase railway motor. It is impossible to say, at present writing, in how far this difficulty has been or can be remedied.

By means of a complicated commutator with low voltage per bar and auxiliary resistance to check the rush of current when two bars are short circuited, the tendency to sparking can certainly be much reduced. The question of output, however, enters the problem in a somewhat troublesome manner. An arc-lighting dynamo for instance may operate beautifully at 5,000 volts with say 6 amperes of current. Doubling the current would greatly increase the trouble from sparking, even with the proper changes in the windings, and the difficulty would be enormously enhanced if the current output were planned for 100 amperes. Exactly the same sort of difficulty is met in designing the commutation of an alternating-current motor, and the complete success of a 15-horse-power machine for given voltage is no guarantee whatever of possible results in a 150-horse-power motor. The limitations thus encountered are merely a question of fact about which it does no good whatever to theorize.

At some point in the continued increase of output, forbidding difficulties are to be anticipated; but whether this point is above or below the requirements of electric railroading remains to be seen.

The single-phase alternating-current motor has two inherent difficulties which no amount of finesse can entirely circumvent. In the first place, there is necessarily a loss from hysteresis in the iron and from residual eddy currents that renders the machine clearly less efficient than a direct-current motor of the same output, by an amount that may be roughly estimated at between 5 and 10 per cent. Second, owing to the fact that the energy supply derived from a simple alternating-current is intermittent, the output of such a motor is, other things being equal, less than that of a direct-current motor of the same effective weight of material, by 25 per cent, more or less. As single-phase motors are practically built, the great care in design and the high grade of magnetic material used tend to lessen the differences both of efficiency and of weight here referred to, the inherent disadvantages being thereby transferred to the cost.

As regards speed regulation, the alternating-current motor has rather the advantage, since by using a transformer capable of supplying various secondary voltages the motors can be worked over a wide range of speed without recourse to rheostatic control. The ordinary series-parallel control has two economical speeds and has to waste energy in resistances at all others. It should be noted, however, that this difference is not practically of much importance, the resistances being used as little as possible, merely to check too sharp changes in speed.

As may be judged from the principles of the alternating-current commutating motor, it can be used upon a direct-current circuit of proper voltage with good results. This advantage has been made much of in recent discussions—rather more, in fact, than can fairly be justified. It is quite true that the motor works easily on either kind of circuit, but the specialization of the structure for alternating current is not altogether advantageous for direct-current working, and the duplicate use produces enormous complication in the wiring and controlling devices, including even the current collectors, of which one must be for high voltage and the other for low. Certain parts of the controlling apparatus may be made to serve in both cases.

The fact is that while the duplicate use is entirely feasible, it is not exactly simple and convenient, so that most engineers are disposed to look upon it somewhat dubiously, as a convenient stop-gap rather than a measure of permanent value.

In summing up the alternating-current traction situation one sees, first, that the new method has its chief and commanding advantage in the greatly simplified distribution—an advantage that rises in importance with every extension of electric traction into wider fields. Extension of electric traction to trunk-line and general railway work may be regarded as practically out of the question with the so-called "standard" direct-current methods. Higher voltage on the working conductors is imperative—so much higher as practically to preclude the use of direct current up to the car. The kind of transforming apparatus and motors used on the cars are of far less importance, especially in the big work just referred to for which electric locomotives would naturally be used.

In the commutating single-phase motor as now developed, one has a most interesting and ingenious machine, possessed of some very valuable properties, but still essentially untried upon the scale necessary to demonstrate its general value. The preliminary experiments

have been promising, while on the other hand the difficulties are of a kind that do not fully disclose themselves in working on a small scale.

The large work with alternating-current locomotives to which the N. Y., N. H. & H. R. R. now stands committed will furnish a most valuable demonstration. If the locomotives now under construction come fully up to their requirements, the work of heavy electric traction is likely to be revolutionized. It does not follow that every electric-railway system will at once be converted to alternating-current practice, for it has not yet been demonstrated that the change would always be worth while. In fact, the manifest advantage of alternating current is essentially a matter of distribution, so that it varies with the relative importance of distribution in the problem considered. The alternating motor equipment is and is likely to remain under some disadvantage in the matter of first cost and maintenance, so that when the final balance is struck, it will be found in favor of alternating current when the element of distribution is above a certain magnitude, and the reverse when it is below that magnitude. Obviously it is not a case for hasty judgment but for deliberate consideration. And an important feature of the matter in its bearing on the future is that a gain quite sufficient to determine the use of alternating current in a new enterprise may be insufficient to justify a radical change in an equipment already in use and which represents a large investment. A similar situation has long existed in electric lighting. Alternating current is used for nearly all new work involving considerable distribution, while for work at short distances, and for extensions of existing direct-current networks, the older method is used—in the latter case sometimes very far beyond the point that would be advisable save for the large investments already made.

This much is certain—that alternating-current traction in some form is highly desirable for much of the future railway work; that it has already made progress enough to deserve serious consideration and to ensure future growth; and finally, that if the large experiments now under way turn out well, alternating-current motors will be pushed into very extensive use both in new work and in the re-equipment of systems in which direct-current traction has been forced beyond its economical limits.

THE SQUARE DEAL IN WORKS MANAGEMENT.

By O. M. Becker.

II. WHAT CAN BE DONE WITH THE SHOP.

In a preceding article, in our issue for January, Mr. Becker inaugurated the present series of papers with an introduction pointing out briefly the conditions which have developed in the manufacturing world with the use and growth of the factory system. He showed that far-seeing and successful managers everywhere were wakening to the necessity (and the direct commercial profit) of considering the welfare of their work people at least as carefully as that of their machines, and that out of this recognition was growing a new and hopeful movement in the adjustment of the relations between employer and employed. In the following paper he takes up, analytically and concretely, the feasible changes in the shop which will lead not only to increased product, but to lessened danger of friction and trouble with employees.—THE EDITORS.

TO such an extent has the "altruistic" spirit grown—the spirit of the "square deal" in the management of employees—that there is an increasing need for men and women qualified to undertake its concrete application in commercial and industrial establishments, just as experts are required for the direction of other branches of business.

In many of the larger producing, trading, and transporting plants, and not a few of the smaller ones, there is at least one person whose time is devoted wholly or in part to looking after the comfort and welfare of the other employees. In most such places this social secretary, welfare manager, or educational director, as he has been variously designated, conceals his real work behind some other presumed to be more conventionally associated with the business. In small establishments such a combination of duties is usually necessary from considerations of economy; and in some larger ones the same arrangement may be desirable. There is, however, a growing disposition to regard the social or welfare work—that is, the work of providing and maintaining decent and agreeable working conditions—not only as legitimate, but as essential, and therefore as an integral division of a business. Experts in all other departments of a business are not apologised for; why should an employer seek excuses for having an expert adviser in matters affecting the physical and social well-being of his people, and therefore the efficiency of his plant? Experience has shown that the American working man, indiscreetly independent as he is at times, is more likely to look with suspicion upon half-way advances made under the cloak of something else than upon an open and

frankly avowed purpose to deal with him as he has a right to expect to be dealt with—to meet him as a man and not to regard him as a mere machine. The employer's honesty of purpose quickly manifests itself in the things he does and the people he sets to doing it. If extended in the right spirit—the moral, fair-minded spirit that characterizes the square deal—and not thrown *at* him as a sop, the American working man quickly meets the employer half-way, and more than half-way, with his co-operation.

Under such circumstances and under a director of broad sympathies, able and willing to rub elbows with the humblest of the workers and not above being one of them—a man or woman keenly appreciative of the tremendous possibilities ahead in such a work—a "Welfare Department" in a business acquires a standing in the eyes of the employees and makes it possible to restore in a measure the old-time personal touch between wage earner and wage payer. Mr. H. H. Vreeland, president of the New York City Railway Company, (the company that operates practically all the surface car lines in the metropolis), undoubtedly has the correct idea with respect to the method of bringing employer and employed into close relationship and incidentally giving them the best possible working conditions. He himself goes among his men, meets with them periodically, and therefore keeps in such close touch with them that there is no occasion for an intermediary except to carry out the details of his plans. The zealous loyalty of his employees attests the soundness of his policy. Where such a course is out of the question, the welfare department should have for its chief function that of intermediation. Its director will stand between the individual employees and the employer, and will represent him in his social relations to them. Its success will be measured absolutely by the extent to which it touches the lives of individuals and elicits responsiveness to that touch; and this in turn depends with equal absoluteness upon the personality of the director and the latitude allowed him. A welfare department organized as a machine and left to run itself with a director as operator, will come as near to a manifestation of the altruistic spirit as a punch press does, and will elicit about as much response. Only actual sympathy, honest purpose, and the real sense of human brotherhood can touch the responsive chord.

The question as to whether the head of a welfare department ought to devote his whole time to this work, or should be charged with other duties connected with the operation of the business, is not to be determined by a dictum. Where the number of employees is

comparatively few, there would be small need for so much time devoted to welfare work alone, except perhaps at the time of its inaugural or organization. In such case the welfare man (or woman) undoubtedly should be an integral part of the business in other capacities also. The fact of being a part of the regular working force—that is, a worker *with* rather than *for* them—gives him a fine opportunity to gain the confidence of the other employees without which little good can be done outside of providing facilities for the observance of the decencies. In some of the largest establishments the same plan has been found to work best. Mr. Nazaro, of the Plymouth Cordage Co., is also head of the construction department, and believes firmly that this is the surest way to acquire a standing among the work people. In one of the large retail stores of Marshall Field & Co., of Chicago, what might be called the welfare activities are not systematized at all; but are watched in a general way by the assistant manager, Mr. Towsley. Nothing better could be desired in the way of *esprit de corps* and loyalty than is to be found among the employees in this great store. Nevertheless there would undoubtedly be greater opportunity for the intermediary of the employer to get into touch with and to be helpful to the individual employee if there were a definite organization with a responsible head, as in the case of the Plymouth Cordage Co. and a good many others, where the welfare director gives all his time to this work alone. One thing may be said with assurance: in any plant employing as many as, say, a thousand people, there will be enough work, if properly undertaken, to keep one person pretty busy, and frequently to require considerable assistance.

While it is difficult at times to draw a distinct line, the work of a welfare department naturally divides itself into two pretty well defined groups: those activities, or rather those conditions, making directly for the comfort and convenience of workers in the performance of their regular tasks; and those ministering to their physical, intellectual, social, and moral wants. The first group are necessarily closely connected with the equipment and operation of the business, and involve no particular co-operation on the part of employees further than proper use of the facilities provided for them. Under this category would be placed such items as proper heating, lighting, ventilation, sanitation, and cleanliness of buildings and premises; safety devices on machinery for the protection of operatives, and appliances for the removal of dust, gases, and waste that would cause discomfort or be dangerous to health; medical attention, at least

A MODERN AMERICAN MODIFICATION OF THE "GARDEN CITY" IDEA.
The plant of the B. F. Sturtevant Co., Hyde Park, Mass., illustrating the tendency to seek the suburbs where relatively cheap land, good air, and freedom from congestion can be secured.

to the extent of providing first-aid assistance in cases of injury or sudden illness, and retiring or rest rooms for women who may be temporarily indisposed; sanitary toilet and lavatory conveniences ministering to the decencies; opportunities for comfortable positions and the elimination of unnecessary exertion while at work and in going to and from it; decent lunching facilities; women overseers for female operatives; and improvement in physical surroundings of work rooms and premises.

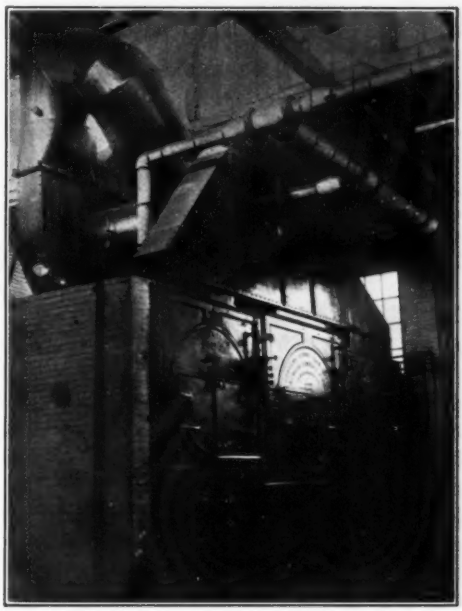
So widespread has become the sense of responsibility in certain of these matters that few new shops are now erected or equipped without careful attention to the conditions that make for the best working environment, including the common decencies. In many recently built plants these things have been most carefully considered. In old shops, built and equipped before anything more than walls, floors, and suitable manufacturing machinery was thought important, there are likely to be practical difficulties in the way of making needed improvements. Of course, there will be instances where the conditions are so abominably bad that sane business considerations would dictate the disuse of the premises for work rooms. Usually, however, the case is by no means hopeless. It is possible by resorting to well-known expedients to work surprising transformations of very unpromising conditions. The only question usually involved in thus making the best of what is at hand by modernizing it as much as possible, is that of expense. However little attention to the safety of the operator may have been given in the designing of machinery and other shop equipment, it is quite possible to cover dangerous parts; to provide collectors and exhausts for dust, gas, or other waste; to supply suitable fire protection and escapes; to install sanitary conveniences; and to do many other things to protect the life or preserve the health of the work people.

A WORKROOM FROM WHICH POSSIBLE OFFENSIVE ODORS ARE ENTIRELY REMOVED.
The box factory of Cadbury Bros. Cocoa Works, Bourneville, England. The cheapest (and therefore most offensive) glue is used; but cowls placed over each work-table and connected with an exhaust system keep the air as unobjectionable as that in any ordinary shop.

In many States there are statutes specifying minimum requirements, sometimes lamentably low, with reference to the protection of employees in factories. Almost every year the minimum is raised; and it is gratifying that employers of labor, especially those of large interests, are inclined to accept gracefully all such legislation, and even to go far beyond the legal requirements. Unfortunately there are managers responsible for shamefully, even criminally, inadequate provisions for the protection of workmen against accidents; managers as yet unregenerate, to whom a dollar in hand looks very much bigger than a finger on hand—or even bigger than a life in jeopardy. The astonishing mental attitude of such men toward the sacredness of human life and the human person is typically illustrated by the remark of a certain superintendent when shown a new safety device. The appliance was designed to prevent the boy and girl operatives at certain machines having their fingers cut off—an accident that frequently happened. When informed of the cost of the device he jocularly remarked, "Hell! fingers don't cost us anything." Happily such men are no longer so numerous as formely in responsible positions. Given, the willingness to provide adequate protection against

accidents and personal injuries, the question is likely to be asked, "What more can we do? Have we not fire escapes, enclosures for rapidly revolving wheels, and other protective devices?" Doubtless most shops and commercial plants observe the letter of the law in respect to the most obvious of these things—particularly when there is a rigid factory inspection. But there are a thousand and one things that necessarily escape the factory inspector, which are nevertheless dangerous to life, limb, or health. The remarkable frequency of small accidents in all sorts of plants must be attributed to the neglect of the management solely—barring possibly the few instances of absolute foolhardiness on the part of the injured after all possible precautions had been taken. Most of these accidents arise from neglect of little things that are easily remedied, if seen. And they *should* be seen. Possibly it would be outside the province of a welfare department to make all inspections of this sort; but undoubtedly there ought to be a close relation between the inspection and that department.

Automatic safety gates and stop clutches for elevators, covers for gears, and the like devices are universally required nowadays. But they are by no means universally kept in a state of efficiency or adequacy. Belts are not usually watched closely, nor always carefully laced or otherwise jointed; holes are allowed in floors; shafting is at times allowed to extend beyond bearings and to have dangerous projections to catch the clothing; belts within the range of the machine man's activity



HOOD OVER BOILER FRONTS, REMOVING EXCESS OF HEAT AND BETTERING THE FIREMAN'S WORKING CONDITIONS.

Plant of B. F. Sturtevant Co., Hyde Park, Mass.

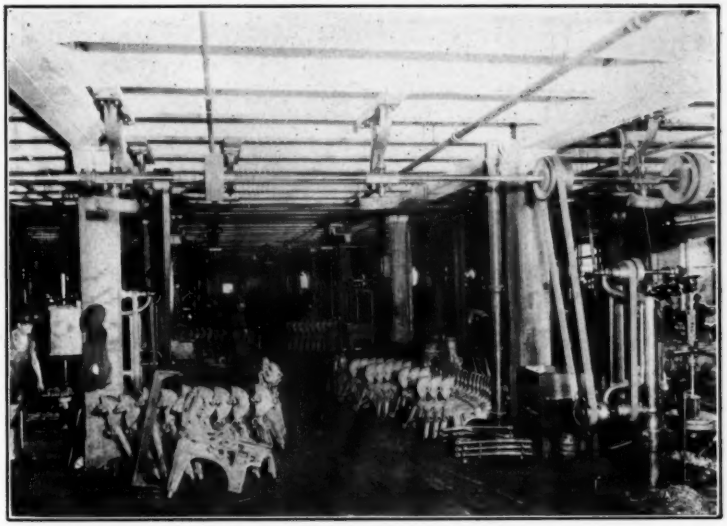
are often left without being cased; and a multitude of other equally insignificant omissions all contribute to swell the number of preventable accidents. It is not enough to say that most accidents result from the carelessness of the injured. There doubtless often is contributory negligence. But no machine or workroom can be said to be properly safeguarded until it is absolutely "fool-proof."

AN EXCELLENT RESULT SECURED IN SPITE OF UNFAVORABLE CONDITIONS OF SHOP CONSTRUCTION.

An old type of building, in which the walls and ceilings are kept whitewashed and a portion of each sash is glazed with ribbed glass. The light is uniformly diffused and cavernous corners are prevented. Note the stools for the use of workmen.
Courtesy of the Jones & Lamson Co.

Very few of the old-time conditions that arose from a disregard for what are now well recognized principles of industrial and commercial practice but can be remedied wholly or in part without prohibitive expense. A badly lighted shop, for instance, might on first consideration be thought beyond improvement without a rebuilding of the walls, and an increase in window space. Such an increase may, indeed, be really necessary; usually, however, the simple expedient of keeping the existing windows clean and the walls and ceiling thoroughly whitewashed or, better still, painted a pleasing light color, will produce an astonishing difference in the lightness and cleanliness of a

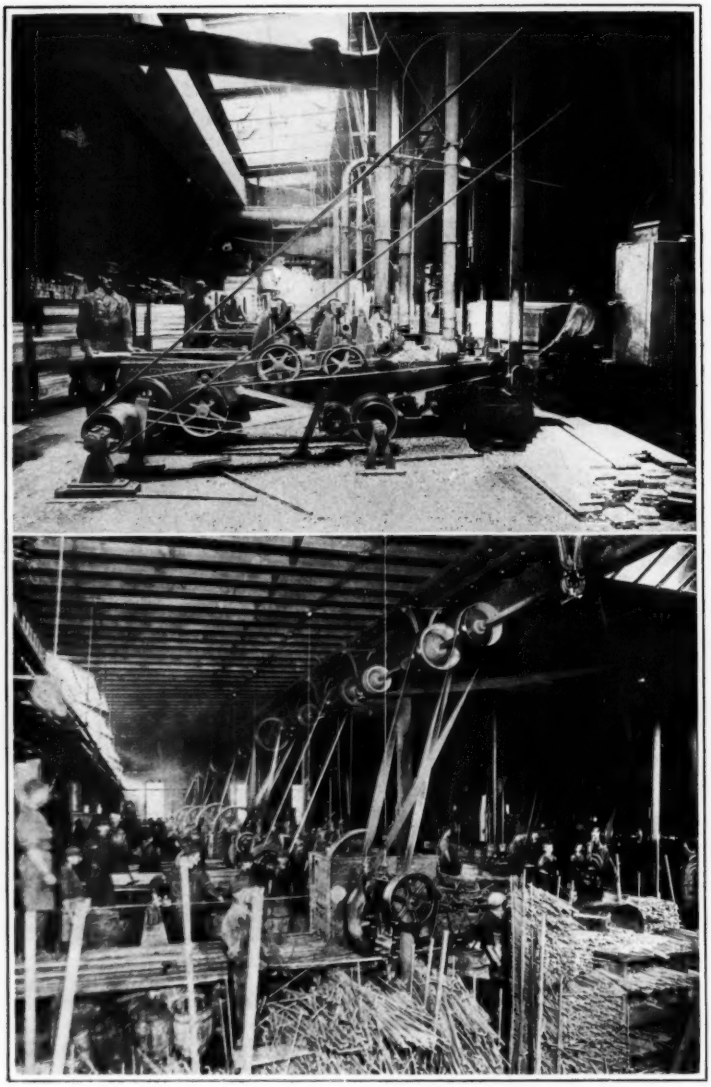
work room. Where high buildings mutually shut off light from each other, whitening the adjacent walls adds greatly to the interior illumination. If to these expedients be added that of using ribbed glass instead of the plain, in part or all of the window sashes, the change is really remarkable. The ribbed glass diffuses the light uniformly throughout the room and does away with that dim, cavernous appearance common in so many work rooms. Where the product requires accurate workmanship the necessity of thorough lighting is of course obvious. But in any case there is no valid reason why men or women should be asked to work in semi-darkness or by unsatisfactory artificial light when God's sunlight may be had so easily. Many a manager pays more in a year for artificial light than would pay for these suggested improvements and others besides.



WHAT A LITTLE WHITEWASHING WILL DO.

The conditions are not ideal—note the unlighted parts, and lack of wardrobe facilities indicated by clothing hanging from the pillars; but the white ceiling quite alters the place from its former conditions.

In the construction of new shops, where ground is not too valuable to permit of one-story buildings, the "saw-tooth" roof method of lighting is favored. In a shop of this construction practically all the light is taken from the north and is diffused by passing through ribbed glass, insuring uniform illumination and the absence of dark corners. There is an additional advantage in that the lighting is from above.



INSTANCES OF UNNECESSARILY BAD LIGHTING.

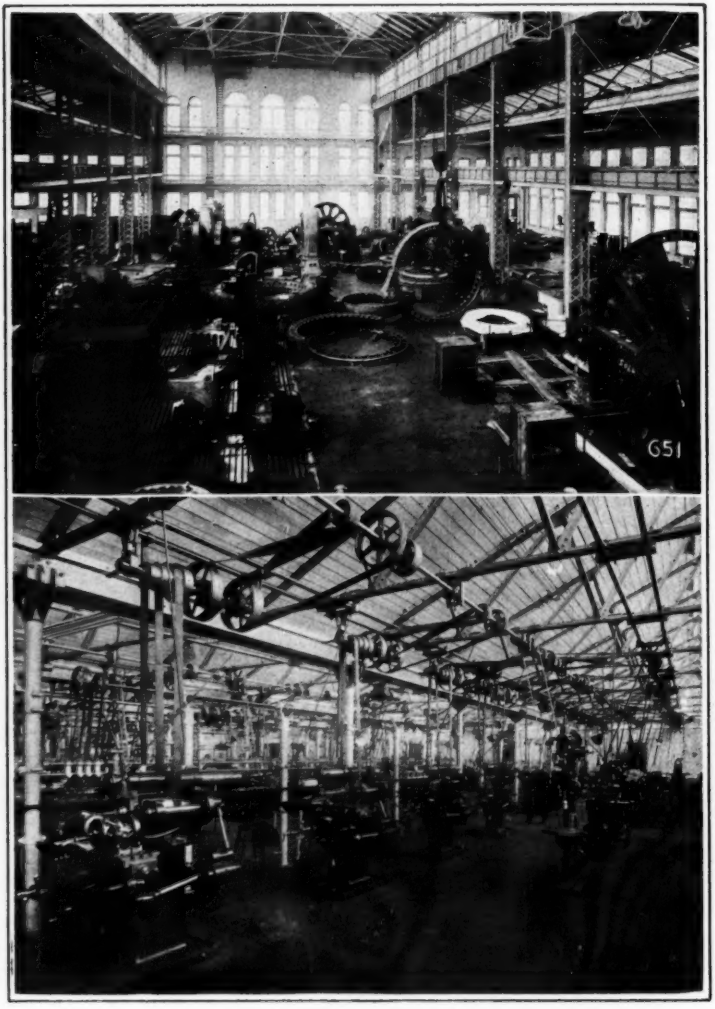
The work illustrated in the lower picture is not of a kind requiring great precision, but men should not be made to work in the semi-darkness enveloping those at the right of the view. And light could be admitted by the roof. The upper figure shows a common type of bad lighting—the center of the shop flooded, and the remaining portions in deep shadow.

The objection formerly made that buildings of this construction could not be made to drain the water properly, and were necessarily leaky, no longer holds good. One of the first of the large shops of such design in this country, that of the Weston Electrical Instrument Co., at Newark, N. J., solved the difficulty very easily. Similar shops are now common enough, though five years ago there was scarcely one in America, outside a few devoted to the textile industry.

WHAT THE MODERN FOUNDRY MAY BE—LIGHT, WELL WARMED IN WINTER, FREE FROM FUMES, AND SAFEGUARDED AGAINST ACCIDENTS.

The lighting is chiefly from the sides, and perhaps not quite so good as in some other shops shown. Deering Works, International Harvester Co., Chicago, Ill.

Another type of shop, peculiarly adapted to erecting or foundry work because of the crane service it permits, is also finding much favor—large buildings with broad central bays unbroken by ceilings, and side bays of several floors. The lighting is from the sides and from windows laid into the roof—the latter always of moulded glass, so as to diffuse the direct light. When ground is too costly to admit



TWO EXAMPLES OF WELL DESIGNED AND WELL ARRANGED SHOPS.

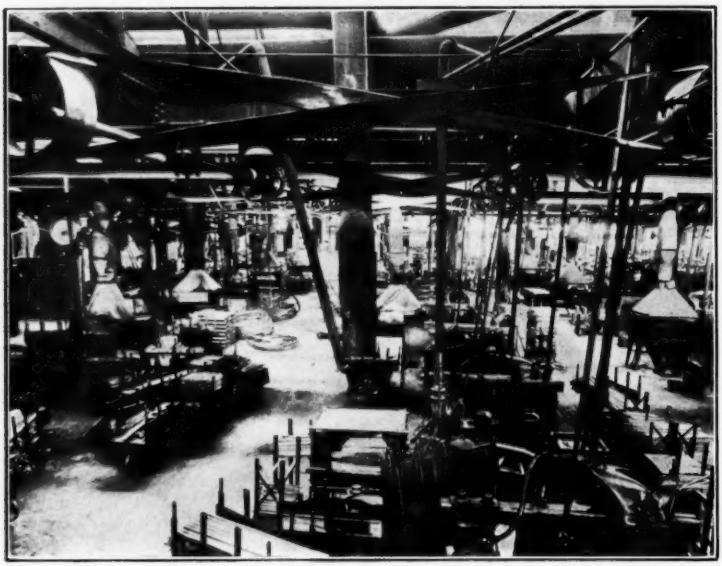
The upper one shows a type of erecting shop which is more and more coming into favor—lighted from all sides and through the roof, and with all necessary arrangements for cleanliness and comfort. The view is taken in shop No. 3 of the Bullock Electric Mfg. Co. (Allis-Chalmers Co.), Cincinnati, O. The lower picture—almost aesthetic in its neatness and order, and yet wholly suggestive of the workshop—shows part of the works of the Weston Electrical Instrument Co., Newark, N. J.

of anything but tall buildings, or where other considerations make such buildings desirable, modern steel construction makes it possible to build shops whose exterior surfaces are almost wholly devoted to window paces. In several recent examples of such design, the window spaces are fitted with double sashes, the upper halves of which are glazed with ribbed glass. In such a building the interior surfaces naturally are smoothly plastered and the floors of cement, so that lightness and cleanness are scarcely to be avoided in them. The double sashes serve the double purpose of preventing the distribution of dust and smoke, and of economizing the heating in winter.

A NOTABLE SUCCESS IN THE DESIGN AND ARRANGEMENT OF A FORGE SHOP. One of the best in America. Plain (but not ugly), and excellently lighted. Note the interior view of the same shop on page 672. Deering Works, International Harvester Co., Chicago.

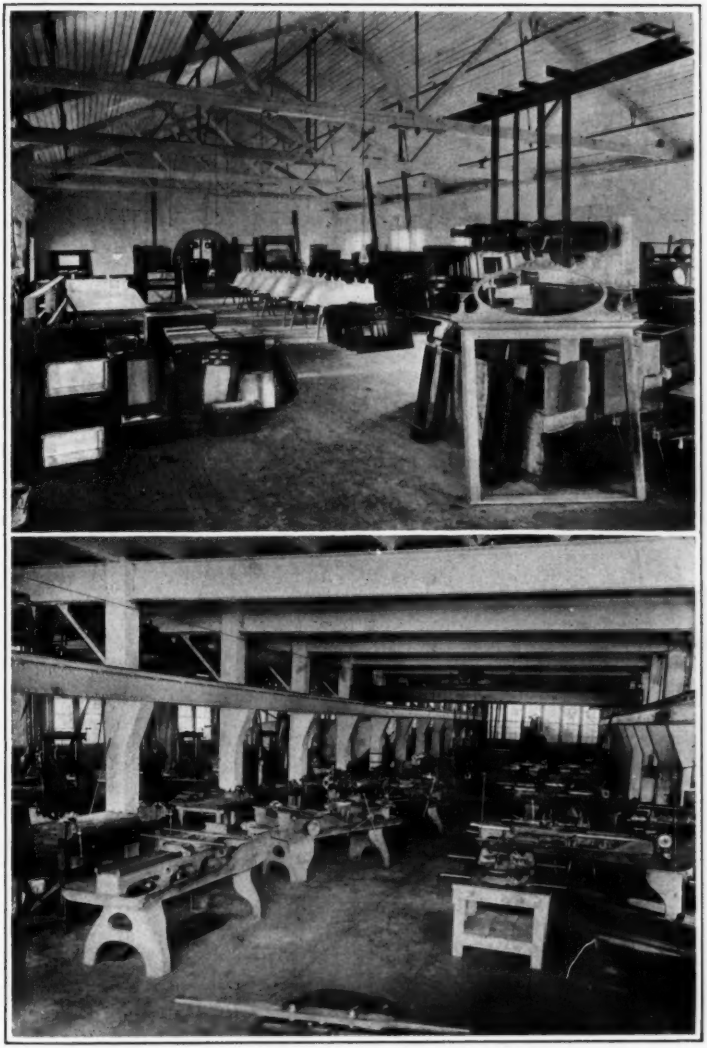
It would doubtless be difficult to point out an employer in the United States so foolish as to work his men in an unwarmed shop in winter. The disadvantage of cold and stiff fingers in turning out rapid and accurate work is too well understood now. Not every superintendent or foreman knows, however, that pure, fresh air is just as necessary as warmth. Many of the newer shops make provision for this; but in most of the older ones the only ventilation to be had is by way of the windows. Judiciously used, window ventilation does very well. Unfortunately, like many another simple and near at hand means, this is not thought of except during hot weather

or in shops where noxious gases fill the air. The ventilation should go on at all times—at night when the shop is deserted as well as when filled with workers. As it is, even when sufficient ventilation is allowed during the day, the first thing the watchman does at night is to close securely every window, shutting in all the dust-laden and very likely devitalized air for use next day, often malodorous with the fumes and gases incident to the manufacturing process carried on. It would seem that the least that can reasonably be done, at times when windows may not be left open, is to arrange some means for intro-



THE INTERIOR OF A THOROUGHLY APPOINTED FORGE SHOP.
Good light, thorough ventilation, cement floor; hoods over the heating furnaces are properly proportioned, and connected with exhaust pipes large enough to carry away all fume and smoke. Deering Works, International Harvester Co., Chicago.

ducing fresh air through simple ventilators placed in the windows, which will deflect the air coming in at the windward side of the building so as to avoid drafts upon those in the room. A small motor fan often helps to make such a method quite effective. Inattention to this matter usually brings its own immediate punishment in the reduced activity of the workers and their consequently diminished output. The injury to the health of the workers is often serious; and many a case of tuberculosis is directly traceable to an unventilated or improperly ventilated work room.



EXCELLENT RESULTS SECURED IN SHOP CONSTRUCTION.

In the upper picture is shown a room which would otherwise be poorly lighted, but which is made bright and clean by light-painted walls and ceiling. It is a finishing shop of the N. O. Nelson Mfg. Co., Leclair, Ill. The lower one exhibits a strictly modern style of shop construction—steel and cement throughout, nearly all wall space devoted to windows, and these filled with ribbed glass. Satisfactory heating and ventilation. Jones & Lamson Machine Co., Springfield, Vt.

RIGHT AND WRONG IN THE MATTER OF SPECIAL VENTILATING DEVICES.

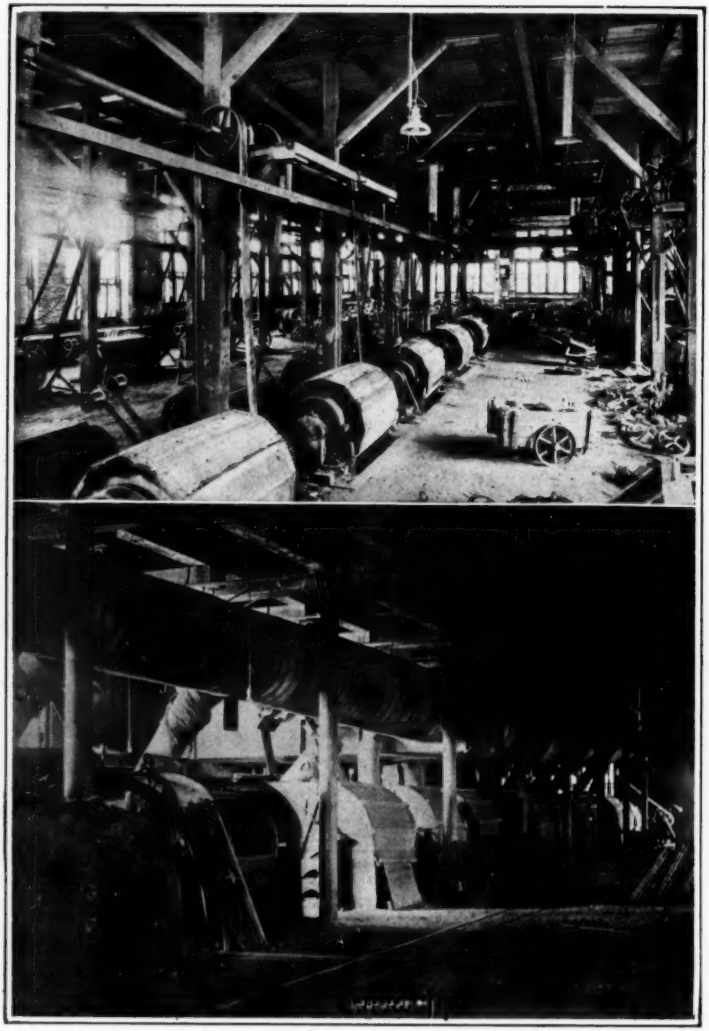
In the department illustrated in the lower view, operatives are at work opening bales of dusty fibre in a room with absolutely no provision for removing dust other than by opening the windows. The upper picture—taken in the same works—shows provisions for dust removal which are all that can be desired. The semi-hooded grinders connect with exhausts which draw away practically all the dust.

For the proper ventilation of shops wherein the atmosphere is quickly contaminated with gases or dust, windows are obviously inadequate. In such cases it is usually necessary to install a system of pipes and forced drafts. Nor is it enough to install it. Unless properly designed, such a system may actually be worse than useless. Consider what would happen in, say, a school building, were the air supplied for ventilating and warming the rooms that which was exhausted from those same rooms, over and over again. And yet there are a good many so-called heating and ventilating systems installed in factories which do just this.

A THOROUGHLY EQUIPPED AND SAFELY PROTECTED GRINDING ROOM.
Hoods for each wheel, with down-draft exhaust, remove all dust and particles.

In some States there are statutory provisions forbidding the contamination of the air in work rooms by dust from grinders, and possibly also in some instances by other common methods. The former great percentage of tuberculosis among men working as grinders has been much reduced since the practice of placing hoods connected with exhaust systems over dry-grinding wheels has become common.

But there are many other sources of dust than this. The worst conditions probably are to be found in some "milling rooms" attached to foundries. Ordinarily a large part of the dust formed in the "mill" escapes into the room. No system of ventilation, even were any such installed in a mill room thus equippped, could keep the air free of



ADEQUATE AND INADEQUATE DUST-REMOVING APPLIANCES IN FOUNDRY MILLING ROOMS.

The lower view shows the equipment in one of the largest American foundries. The tumbling barrels are of old type, allowing much dust to escape. Wooden enclosures with canvas flaps exhausting into the pipe above are installed, but so much dust escapes that the air of the room is thick by day and the dust on the floor lies deep by night. In the upper view (taken in the new Deering foundry) the rattlers are provided with positive down draft, the dust being carried into a duct underneath. There is almost no dust escaping into the room.

dust. The modern "mill" or "rattler" is designed with dust-proof casing, and proper down-draft exhausts connecting with the interior through a hollow-bearing shaft or similar device. There is no reason why the old-style "rattlers" could not be made dust-proof by an outer casing, properly connected with an exhaust; and indeed this is done in a few cases that I know of—but they are very few, indeed.

It is perhaps unnecessary to mention other operations which defile the air of the work room. But it is worth while to point out that wherever any such operation is carried on it is highly important to make provision for carrying off the dust or other recrement.

From a sanitary point of view it is important to keep work rooms clean.. Considerations of economy also point the same moral. Janitor service of course entails expense, but slovenly workmen entail a greater loss; and slovenly workmen and workmanship are legitimately begotten of slovenly surroundings. If a shop is allowed to be dirty and cluttered up with waste materials, or even with good material in disorder, its character is impressed with absolute certainty on its occupants. There is doubtless much truth in the phrase that a shop is known by the workmen employed in it; but it is at least equally true that a workman is known by the kind of shop he works in. If he finds slip-shod management, which certainly is the case if disorder and filth prevail, nothing could be more natural than that he should come to regard such conditions as good enough and quite fulfilling the requirements.

Keeping a shop clean is not so difficult a matter as might be supposed. In old buildings, put up with reference to little more than service as shelter for certain machinery, sanitation and cleanliness were well-nigh out of the question. Loosely laid floors raining dust and refuse upon the workmen in the rooms below, and rough walls and ceilings collecting masses of dust later to be jarred loose and to fill the air of the work rooms, are practically a thing of the past. Nowadays shops are constructed with reference to convenient and quick production, and therefore the cement floor and smooth wall and ceiling are much in favor. But even wooden floors can be laid close enough, and now are usually so laid, to prevent dust and waste from sifting through to the discomfort of those below. Under such conditions it is a matter of small expense to keep a shop reasonably neat and clean. Orderly arrangement of materials and proper care of their machines by the workmen, frequent sweeping, and occasional coatings of white paint or whitewash, are a combination that makes an astonishing difference in the spirit of a shop.

Manifestly there is a difference in shops, the difficulty of keeping one presentable depending very much upon the nature of the work carried on in it. Engine rooms have long been proverbial for their cleanliness and tidiness, frequently putting to shame the average housekeeper's kitchen. The modern boiler room, equipped with automatic stokers and coal shoots, is susceptible of equal neatness of appearance. One would not expect an ordinary shop always to be looking spick and span. Nevertheless there are places where just such shops are kept constantly in just this condition. Even a foundry and a rolling mill, of all places presumed to be necessarily about the dirtiest, have been known to present a satisfactorily neat appearance.

TYPE OF MODERN BOILER ROOM, WITH OVERHEAD COAL BINS AND AUTOMATIC STOKERS. It can be kept as clean as most offices, and sometimes with less labor. Green Engineering Co., Chicago.

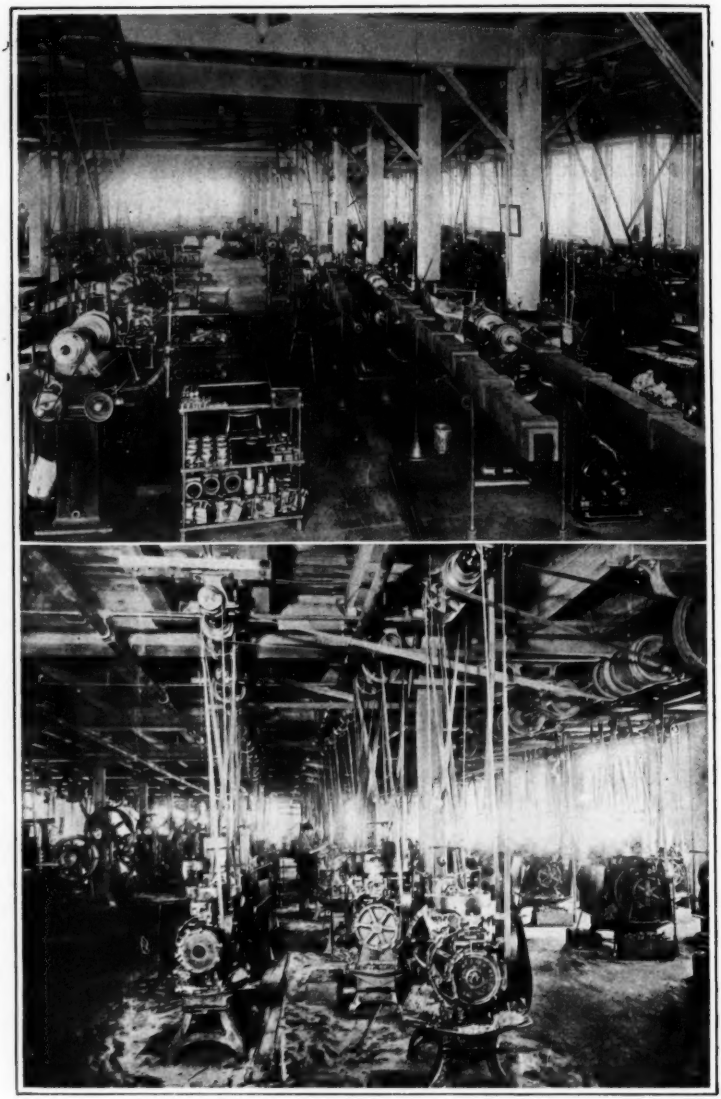
Next to cleanliness in the shop is cleanliness in the person of the work people in it. It is really inspiring to look into a work room filled with trim and tidy operatives. Such neatness and order is equally inspiring to the workers themselves. It is manifestly impossible, however, that such conditions should prevail in all workshops, under present manufacturing practice. Many occupations are in their nature unclean, and perhaps even filthy, so that personal cleanness could not be expected of the worker while at his task. But even in such ex-

treme cases it is possible to provide facilities for cleaning up after the work is done. Time was when even a bucket and water for washing were considered, if thought of at all, as superfluities, possibly to be tolerated in a country shop, but quite out of place in a factory. It is, indeed, quite out of place in these days of improved sanitary appliances; but unfortunately the devices which should supersede the bucket are lamentably inadequate, or more frequently quite wanting.

AN IMPERFECT APPROACH TO EFFECTIVE LAVATORY ARRANGEMENTS.

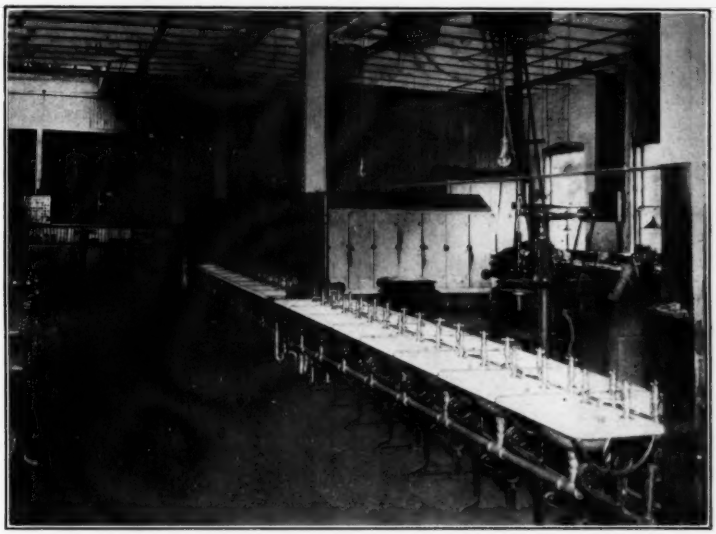
Workmen take unkindly to the single long trough, on account of its promiscuous democracy; moreover, it could hardly be called sanitary. To supply cold water, only, is further inadequate to the requirements of a workshop wash-room.

It is doubtless true that work people in general, such as are to be found in the factories at any rate, lack somewhat in the finer sensibilities; the great majority of them nevertheless are decent and self-respecting men and women, with a distinct preference for personal cleanliness and a desire to make a decent appearance. If they are seen on the streets reeking with the odors and the filth of the shop, it is not ordinarily from choice, but necessity—from lack of opportunity to clean themselves up after a day's work. The embarrassment arising from this necessity is often painful. When it is possible for her to do so, the girl in the mill or dusty shop appears on the street look-



A CONTRAST IN INTERNAL ORDER AND SHOP CLEANLINESS.

The upper view, of an automatic screw-machine room which fairly shines with cleanliness, is taken in the works of the Jones & Lamson Machine Co. The lower is best judged by contrast with what it might be. The expense of providing proper pans for the machines, and thus saving the workman from the necessity of wading through slop and steel turnings to reach his job, would be but slight. The moral effect would be great.

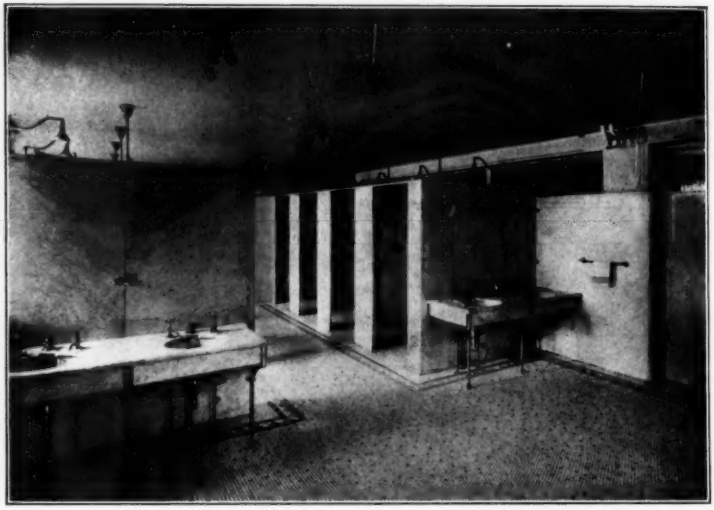


A LAVATORY INSTALLED IN A MACHINE SHOP.

Individual bowls provided with hot and cold water; the men furnish their own soap and towels. Not a man in the shop goes home unwashed. Metal Pattern Shop, McCormick Works, International Harvester Co., Chicago.

ing as tidy as her sister of the department store or office who prides herself on being a lady. The difference, obtrusively apparent, in the appearance of the employees of two shops, the one offering opportunity for washing and a change of clothing, and the other without such conveniences, is surprising; and it is entirely independent of the personality of the work people except in so far as that personality is influenced by the natural drift of the superior men and women toward the shop offering the better conditions.

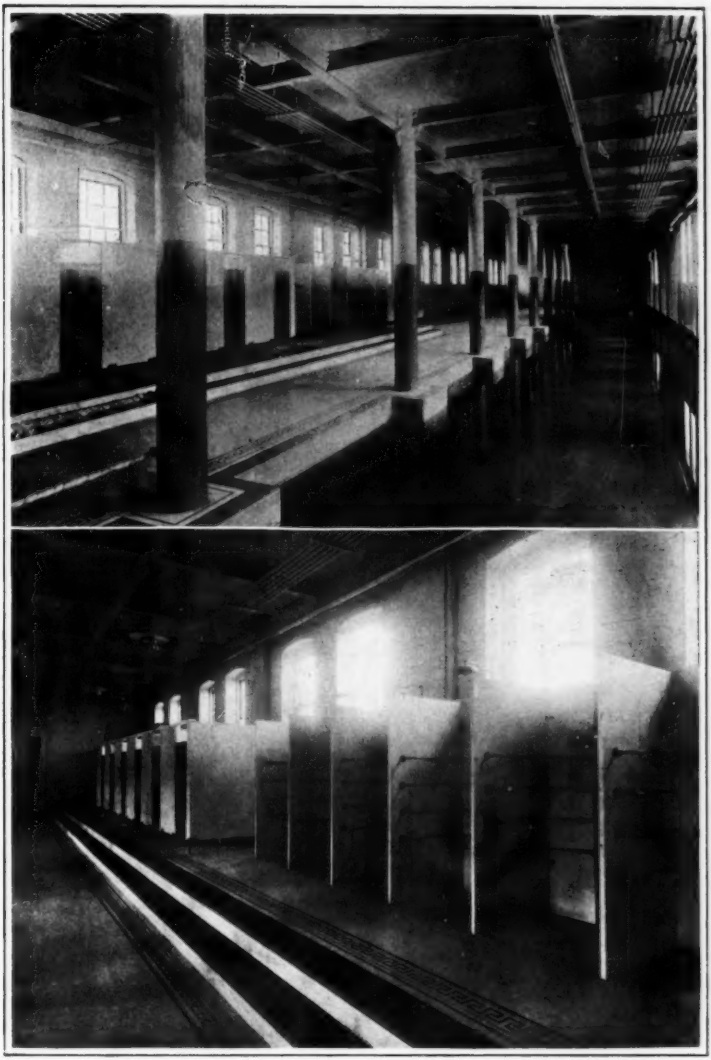
The new idea is that every shop should have within easy reach a satisfactory lavatory equipment and lockers connected with a changing room. The old way of hanging the street clothing against the grimy shop walls to catch the floating dust, and leaving the shop clothing (if any change was made at all) on the floor where it was stripped off at night until it should be required again next morning, is in accord with the old way of inviting workmen to wash up from a dirty and unsanitary bucket filled with cold water. There are, however, so-called lavatories that are little better than the odorous bucket, and lockers that are little improvement over the former peg on the wall. Some employers have expressed surprise that their workmen



AN ELABORATE LAVATORY AND BATH FOR WOMEN EMPLOYEES.
Factory of the National Food Co., Niagara Falls, N. Y. They say it is "worth while."

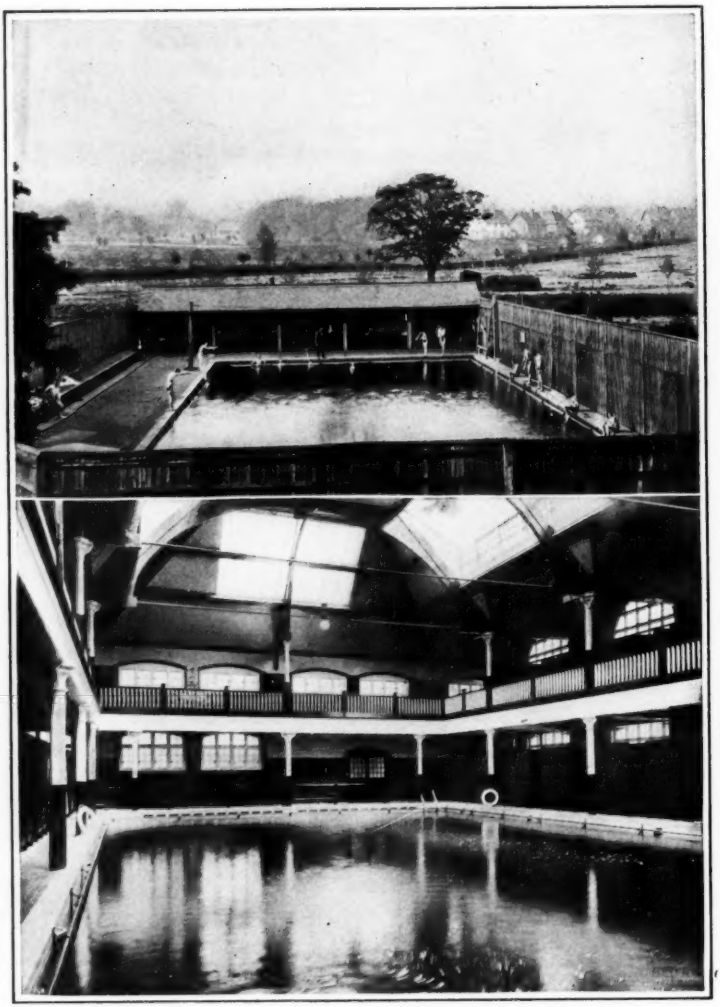
did not make use of such facilities after they had been supplied. The reason is in such cases usually not far to seek.

The usual method in the past, when anything was done at all, was generally to put up a long trough, supplied with cold water. This, and nothing more in the way of lavatories. Anybody who has ever tried to wash off shop dirt and grease with cold water, even when well soaped, will see at once why a workman will prefer to go dirty until he reaches home and hot water, soap, and towel. Furthermore, the long trough, even if hot water be supplied, is unsanitary; and its promiscuous democracy is rather more than is to be expected, even of democratic workingmen. The surprising thing is not that such facilities are so little used, but that they are used at all. Very likely there are shops whose working force would need educating up to the use of anything of the kind, no matter how convenient or agreeable; but in the average shop a proper equipment never yet has gone to waste for lack of use. It is perhaps too much to expect, or even to hope, that people of the type usually found nowadays in those shops whose work, from its nature and the pay it commands, falls into the hands of the most ignorant and incapable, should at once change the habits acquired during a lifetime spent in working surroundings discouraging all efforts at cleanliness, and probably decency also. Even so, the em-



A REALIZATION OF THE IDEAL IN BATHING FACILITIES FOR THE SHOP.

In the upper view, is shown the means adopted to make the necessary water-storage for power purposes serve as a swimming basin. The lower picture is of shower, needle, and tub baths. Both are at the works of the Weston Electrical Instrument Co. It must be borne in mind that "the highest possible efficiency" was everywhere the controling idea in the construction of this plant.



BATHS IN THE BOURNEVILLE ESTABLISHMENT, ENGLAND.

The upper picture illustrates an open-air swimming pool, of very simple design, for the male employees, the lower one shows the girls' bath, with swimming pool and dressing rooms.

ployer is not thereby excused from doing his duty by offering the facilities that help so largely to the creation of a healthy self respect.

A foundry manager argued not long since that if he provided his men with the conveniences I proposed (the toilet-room provided for them was the out-of-doors and a scantling supported by two stakes set into the ground) and they actually came to make use of them, they would become too "high-toned" to work in his shop, and he would be obliged to pay higher wages or to be taking on new men all the time. Undoubtedly the "tone" of the workmen would be raised. And as for the rest, experience does not show that there is difficulty in keeping men in shops, of whatsoever sort, where the "square deal" obtains, at the prevailing wage rate.

The lavatory, to be satisfactory, should have a sufficient number of separate bowls, no matter how simple; hot and cold water; an arrangement for supplying soap; and some sort of towel service. The bowls may be only ordinary basins so arranged that their contents may be tipped into a drain trough below. The modern enameled-ware stationary bowl is of course preferable; but the first described can be very cheaply installed, which may be a consideration. The hot and cold water are not necessarily drawn from supply pipes, though that is much the better way. A steam pipe for heating a sufficient supply at the proper time will do, if the better plan be not feasible for the time being. As to soap and towel service, the workmen are usually willing to supply themselves. The superiority of a regular service and the small expense involved suggests the advantage of its being undertaken by the management.

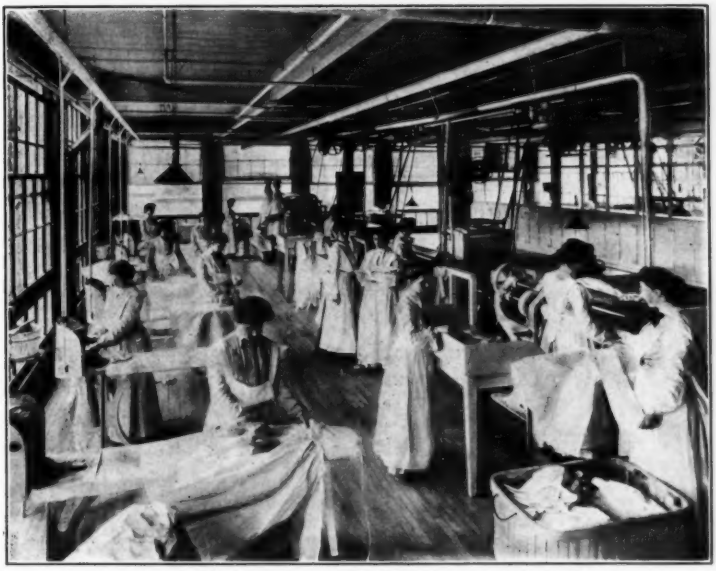
For some classes of shops—those in which the operations are in their nature dusty, or for any reason occasion a great deal of perspiration—wash bowls do not sufficiently meet the situation. In such cases the whole body becomes more or less filthy, and needs a bath. The shower bath fully satisfies the need under such circumstances. These can be simple or elaborate, the same as all other sanitary equipment. In a few establishments the bath and lavatory appliances are not surpassed in elegance by those of the best hotels. For foundry or coal-mine operatives such equipment is manifestly out of place—too fine to be used; and the simplest styles, if properly installed, are not only good enough, but the only ones that would be much used. The essential requirements are reasonable privacy, plenty of water of suitable temperature, soap, and towels. Such are now to be found in many up-to-date foundries and similar shops.

The idea of cleanliness is in some instances still further developed

by some employers. Under any but exceptional circumstances the working clothes inevitably get soiled, and not infrequently very dirty. A clean shop implies cleanly clothed work people. In an increasing number of factories, therefore, the laundry is an essential part of the equipment. In some cases the work garments are laundered for the employees, usually free of charge. In others the management supplies, at a stated charge or free, as the case may be, outer garments for use in the shops and keeps them properly laundered without expense to the employees. In some establishments, as for instance factories producing food stuffs, where scrupulous cleanliness is essential, such a course is almost necessary. In paint mills and similar factories it is very desirable as a measure of protection to the health of the operatives. In every factory there would be a gain were cleanliness and neatness thus encouraged.

A substitute for the factory laundry, satisfactory as far as it goes, is that adopted in one large plant, and doubtless in use in others; namely, that of allowing some laundry to send its representative through the work rooms at stated times to collect garments for laundering from those work people wishing to take advantage of the service and willing to pay the cost. Since the laundry privilege was

STEAM LAUNDRY FOR TREATING EMPLOYEES' SHOP CLOTHING, FREE OF CHARGE.
In some of the departments a daily change is provided. Factory of the Sherwin-Williams Co., Cleveland, Ohio.



AN EXAMPLE OF A MODEL MACHINE-SHOP LAUNDRY.
Situated on a top floor, well lighted and ventilated, and equipped with modern labor-saving appliances. Uniforms are issued to certain classes of employees; laundering is free of charge. National Cash Register Co.

granted in this factory there has been a noticeable improvement in the appearance of the shop people. Furthermore, there is an increasing disposition to make use of the opportunity thus afforded. That is to say, the shop people are educating themselves in this particular respect, simply by the tolerance of the management, which is at no expense whatever.

Another expedient which serves a useful purpose is that employed at a few mines. In the "changing house," (Cleveland-Cliffs Iron Co., Ishpeming, Mich.) there are, besides the wash basins, shower baths, and lockers, racks supplied with steam coils, whereon the perspiration-soaked working clothes may be spread and thoroughly dried before being worn again. The comfort, to say nothing of the advantage from a sanitary point of view, derived from this thoughtful arrangement scarcely needs to be pointed out.

Similar arrangement, sometimes in the form of lockers provided with steam coils, has been installed in certain department stores and factories to dry the outer garments of women employees obliged to expose themselves in rainy weather—an arrangement that saves many a cough and possible illness.

PRESENT CONDITIONS SOUTHERN ALASKAN MINING DEVELOPMENT.

By Wm. M. Brewer.

IN discussing this subject I propose to confine myself to that portion of Alaska which embraces the mainland along the coast line and adjacent islands, from the south end of Prince of Wales Island to Kodiak Island lying to the east of the Alaskan Peninsula. Within this area are located nearly all of the quartz or lode mines so far discovered in United States territory in the great North Land, but few placer diggings—in fact, none of the placer camps which are today receiving so much attention and yielding such phenomenal outputs of gold dust and nuggets.

When it is considered that the length of this coast line, according to the route travelled by the steamers which make regular trips to those Alaskan ports to the westward from Sitka, is about 1,600 miles, via what is known as the inside channel, it can readily be understood why I confine myself within the boundaries given, and do not propose to attempt to discuss the development in the placer camps in the more northerly portion, which covers a far larger area.

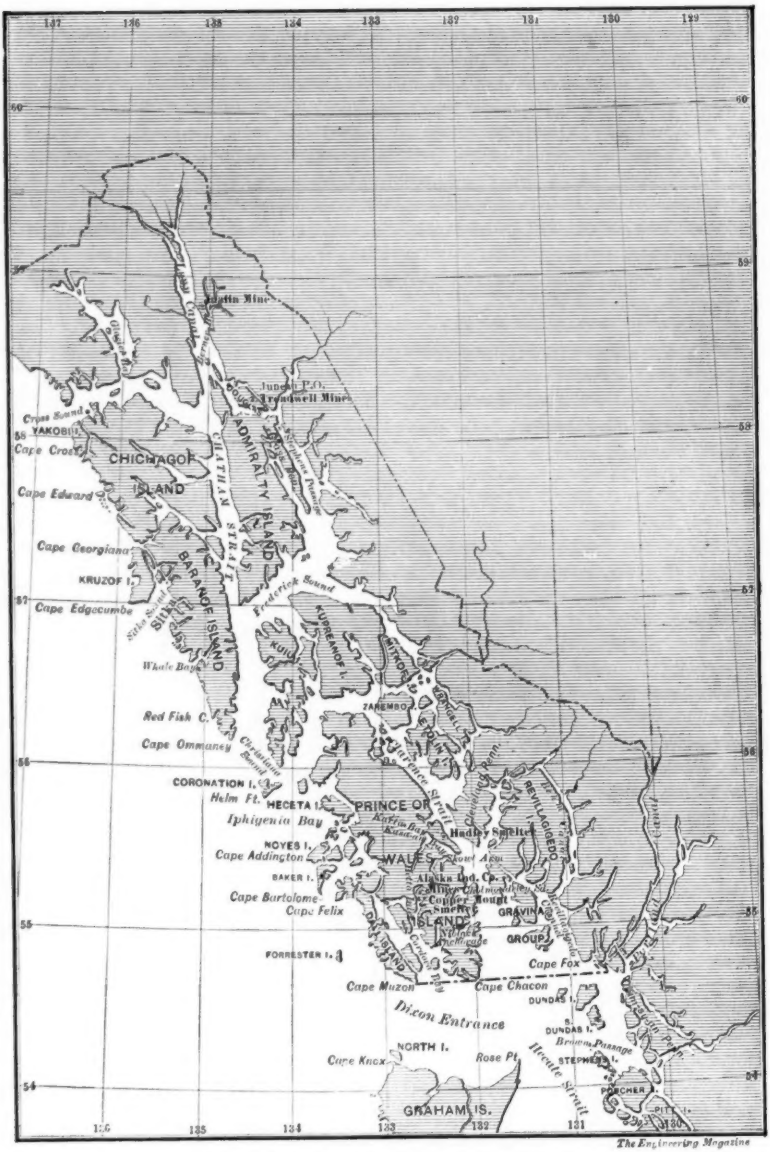
Except the Juneau district, where placer mines were operated as early as 1884 (when gold-bearing gravel was discovered in Silver Bow Basin, and the famous Alaska Treadwell quartz mine was located) all the territory described in this article was practically *terra incognita* so far as concerns its mineral resources, until after the discovery of placer gold in the Canadian Yukon or Klondike proper, in 1896. One does not wonder at this, either, when he has sailed along the coast and observed the difficulties to be encountered by the explorer. Viewed from the deck of the vessel, the dense growth of underbrush, almost impenetrable forests, and precipitous mountain ranges, in many of which are glaciers covering enormous areas, apparently present obstacles which even the hardiest and most venturesome prospector would hesitate before attempting to overcome. However, of the many thousands who started to cross the passes and travel down the Yukon River to the Klondike, a few took up the task of prospecting along the coast line. They argued that other "Treadwells" might

be found, and that reasoning was to a great extent responsible for the present condition of the development of lode mining on Prince of Wales Island, Prince William Sound, La Touche Island, Illiamna Bay, and near Sunrise City on Turnagain Arm, the head of Cook's Inlet. Of course by far the most extensive development has been carried on in the Juneau district, where the Treadwell group of mines alone have produced upwards of $21,000,000 in bullion since 1884, to say nothing of other mines in the same district; but in this article I propose to start my description of the districts at the southern boundary of Alaska and take up each camp from that point of geographical order, from south to northwest rather than according to its importance or age.

Prince of Wales Island.—Previous to 1898 but little prospecting had been done on this island, and that had been confined to the western side, chiefly in the vicinity of Hetta Inlet. Since then, and especially since 1900, the island has been quite extensively explored, until today there are mining camps located every few miles along the eastern coast line in addition to those on Hetta Inlet on the west side.

There are two smelting plants, one owned by the Brown Alaska Co., with a capacity to treat about 400 tons of copper ore per day, situated on the east side of the island at Hadley, on the north side of the Kasaan Peninsula; the other owned by the Alaska Copper Co., with a capacity of about 200 tons of copper ore per day, situated at Copper Mount on Hetta Inlet. The first-mentioned of these was erected to treat the ore from the "Mamie" mine, situated near the top of the mountain on Kasaan Peninsula about 1½ miles from the smelter, and the last-mentioned to treat the ore from the group of copper properties situated on a high mountain in the immediate vicinity of the smelter, which were the first discoveries of copper-ore deposits on the island. During the past year more serious attempts at systematic development have been made on this island than during all the previous years since the first discoveries of ore bodies.

The geology of Prince of Wales Island can hardly be worked out in detail for years to come, notwithstanding the good work that is being done annually by members of the United States Geological Survey. The surface is covered with so much moss, underbrush, and fallen timber that the natural exposures of the rock formations, except where mountain streams have cut their channels, are very few and far between and usually near the summits; to climb these without the aid of beaten trails is really a formidable undertaking, and means that the explorer must pack on his back his blankets and supplies, and travel very slowly.



The Engineering Magazine

A PORTION OF THE SOUTHERN ALASKAN COAST.

From the chart of the Coast and Geodetic Survey.

Hetta Inlet is a long arm of the sea which penetrates into the Island a distance of about thirty miles. About five miles above the properties of the Alaska Copper Co. is situated Jumbo Basin, only a comparatively short distance from the southeasterly shore of the inlet. In this basin are located a portion of the properties owned by the Alaska Industrial Co., on which a considerable quantity of development work has been done during the past five years. At the present time tramways are being constructed to convey the ore from these properties to the shore.

There are besides the properties referred to quite a large number of prospects in the mountains in the vicinity of this inlet, on which assessment work has been done; one of the most promising is a claim located in January last by H. C. Corbin on which he discovered an ore body of considerable extent, as has been demonstrated by actual work. The distance from this ore body to a deep-water wharf is less than half a mile. The location of this mineral claim is nearly midway along the coast line between Copper Mount and the landing for Jumbo Basin.

The general character of ore is chalcopyrite, except on the Alaska Copper Company's property where quite a considerable tonnage of copper-carbonate ore occurs at an altitude of about 4,500 feet above sea level. The altitude of the other occurrences is much lower than this, and there is no oxidized zone; in fact, so far as I have observed, there is no well defined zone of oxidation on Prince of Wales Island except the occurrence referred to on Copper Mountain.

From the head of Hetta Inlet across the island to the head of Cholmondeley Sound on the east side is a distance of only about 4 miles over a very low divide, the summit of which does not exceed 250 feet. This is the route generally travelled from the west side to the east, and as there are no other properties on the west side of the island that have been developed to any appreciable extent I will cross this portage in this description and take up those properties on the east side that have been opened up there.

From Cholmondeley Sound one sails into Clarence Strait, a wide sheet of water which separates Prince of Wales Island from Annette and Graviana Islands. A few miles southwesterly from the entrance to Cholmondeley Sound down Clarence Strait is situated Niblack Anchorage, where are located some extensive bodies of chalcopyrite ore occurring in a greenstone country rock. One of these is being operated by the Niblack Copper Co., which last winter built wharf, bunkers, and tramways from the mine shaft situated only a few hundred feet from deep water. This company has since shipped about

10,000 tons of ore to the smelter at Tacoma in the State of Washington.

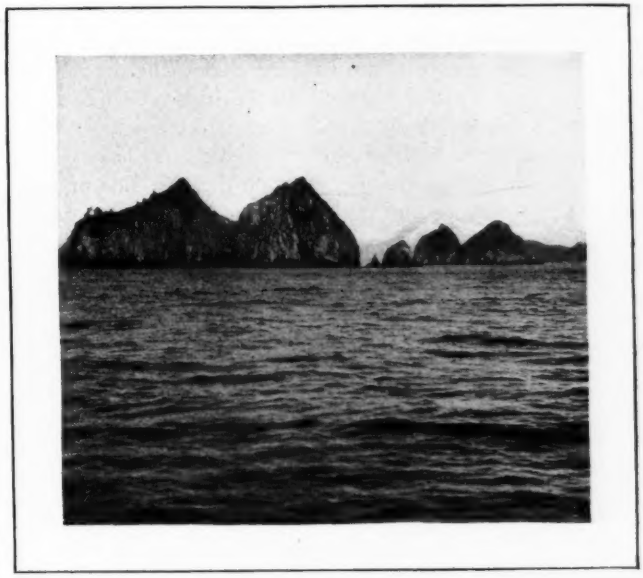
Leaving Niblack Anchorage and travelling a few miles up the coast one reaches Dolomi mining camp, where operations have been carried on for the past five years on some comparatively narrow veins of gold-bearing quartz, partially free-milling. Some of this quartz carries phenomenal values, the gold contents reaching as high as 18 ounces to the ton. These samples were from the Valparaiso mine, which is the most extensively developed in the camp. On another property in this camp a small stamp mill was erected some time ago and operated until recently. It is however more economical and also more profitable to ship this character of ore to a smelter than to treat it by amalgamation, unless very good concentration is effected.

After leaving Dolomi one has to travel along the east coast of Prince of Wales Island about twenty miles, or to Skowl Arm, a beautiful bay affording excellent anchorage, to reach the next mineral property where any extensive operations have been carried on. There the Omar Mining Co. is developing and operating the Khayyam group of mineral claims located in the mountains about four miles from the shore. This company has constructed wharf, bunkers, a gravity tramway to the foot of the mountain a distance of nearly three miles, and an aerial tramway up the mountain to the mine 4,600 feet away, and is shipping ore to the Smelter of the Tyee Copper Co. at Ladysmith, Vancouver Island, British Columbia, for treatment. The ore body on this property differs in many respects from any of those already referred to. In character the ore is a pyrrhotite closely associated with iron pyrites and chalcopyrite. Cross cutting and drifting have demonstrated that near the surface the ore body possesses very considerable extent, and if this extent remains constant as greater depth is attained the tonnage from this property will be immense.

The next mineral-bearing zone is found on Kasaan Peninsula and in the mountains at the head of Kasaan Bay and Karta Bay, which is to all intents and purposes a portion of Kasaan Bay.

At Hollis mining camp at the head of Kasaan Bay there occur several veins of gold-bearing quartz very similar in character to those referred to in the Dolomi Camp, while at the head of Karta Bay the ore bodies are chalcopyrite, in a magnetite gangue in some instances and closely associated with pyrrhotite in other cases.

In the Hollis Camp the ore so far found has been treated by amalgamation in small stamp mills, but in the camp at the head of Karta



CAPE ST. ELIAS, ALASKAN COAST.

Bay the ore mined has necessarily been shipped to smelters, and during the latter portion of the present year one property, known as the Rush and Brown, has been operated under lease by the Alaska Copper Co., and another known as the Newell and Metzdorf is being operated under option by the Britannia Smelting Co., owners of the Crofton smelter on the east coast of Vancouver Island.

On Kasaan Peninsula proper the chief development work done up to the present time has been confined to the Mamie, owned by the Brown Alaska Co., the Stevenstown, owned by Sam Silverman and Associates, the Mt. Andrew, under option to the Britannia Smelting Co., and the White Eagle, owned by Sam Silverman and Associates. All of these properties are located at and near the summit of the mountain which really forms the Peninsula. The ore bodies are more or less extensive deposits of magnetite, carrying variable values in copper contained in chalcopyrite disseminated through the magnetite in particles of variable size. The general character of the country rock is a greenstone, much of it resembling a diabase or diorite, and occurring as enormous intrusive masses and dykes which have metamorphosed the limestone with which it contacts altering it to crystalline. Some of the ore bodies occur as contact deposits be-

tween the limestone and greenstone, while others occur as lenses in the greenstone. Both the Mamie and Stevenstown have been developed during the past year into shipping mines, the ore being transported by tramway to the Brown Alaska Company's Smelter at Hadley situated on the northerly side of the Peninsula.

In addition to the foregoing developments there have been operations carried on during the past year on the east side of Prince of Wales Island in quarrying marble for building and decorative purposes.

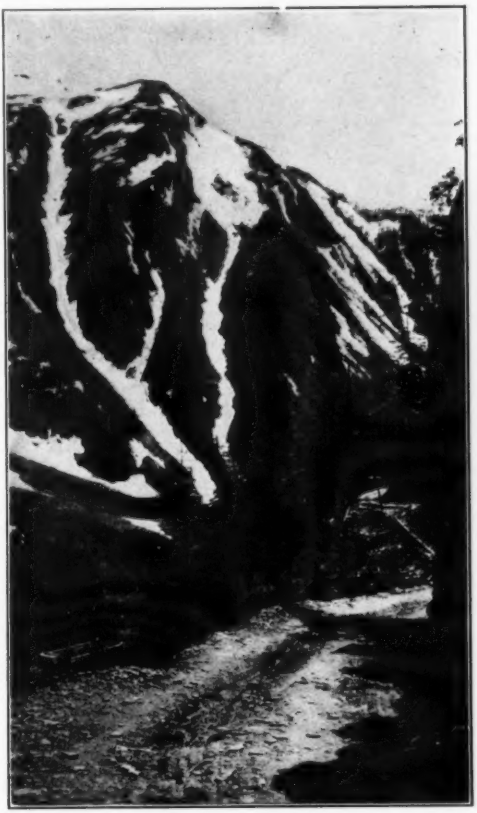
Capital was brought into the Kasaan camp in larger amounts and at an earlier date than into most of those on Prince of Wales Island. This has resulted in the building of the smelter at Hadley on the northerly side of the peninsula, as well as in the extensive development which has been carried on at the Mamie, Stevenstown, Mt. Andrews, White Eagle, and other mineral claims. From the two first mentioned during the past year about 25,000 tons of ore have been mined and delivered at the smelter.

The operations of the smelters on Prince of Wales Island will be watched with a good deal of interest, for the reason that all the fuel will have to be freighted either from Puget Sound or Vancouver Island, which means in either case an ocean haulage of about 600 miles in the direction that has always commanded high freight rates. Fuel from Vancouver Island will be subject to a duty, but its superiority in quality over Washington fuel is so generally recognised that it is almost certain the smelting companies will find it more profitable to use that fuel and pay the duty than to attempt to use Puget Sound coke or coal. Up to the present writing, active operations can hardly be said to have commenced at either of the smelting plants on Prince of Wales Island, but the managements of both are concluding arrangements to blow in for a steady run at once.

Revillagigedo and Graviana Islands.—On the islands lying between Prince of Wales and the mainland but comparatively few discoveries of ore bodies have been made, although, with the exception of Annette Island which is considered an Indian Reservation and on which no prospecting by white men is allowed, considerable prospecting has been done on Revillagigedo, Graviana, and Grindell Islands. On Revillagigedo, quartz veins carrying gold values partially free-milling were discovered some years back, and on the Sea Level group of claims a stamp mill was erected in 1901 and operated for about a year. This is at present idle, owing to some legal questions regarding ownership. On Graviana Island gold-bearing quartz occurs in a talcose-schist country rock which carries sufficient values to warrant

mining and milling operations. Some specimens of this ore are of exceptionally high grade and show particles of free gold as large as grains of coffee, and when sorted with reasonable care the ore carries about $30.00 to the ton.

The prevailing country rock on both of these islands is schist, much of it being garnetiferous and talcoid in character. Sufficient exploration has not been done to determine the full extent of this belt of schist, either as to its width or length, but it is interesting to note that country rock of similar character is found at other points along the coast towards the north-west, notably in the vicinity of Wrangell, and also in the Juneau District, but no discoveries of ore bodies of importance have been reported either on islands, or on the mainland between Prince of Wales and Snettisham Bay which may be considered the south-easterly boundary of the Juneau District.



IN SILVER BOW CAÑON.

Juneau District.—Berner's Bay, a harbor on the East side of Lynn Canal, may be considered the north-westerly boundary. The greatest activity at the present time in this district is seen in Douglas Island, where are situated the Alaska-Treadwell, Alaska-Mexican, and Ready Bullion mines; in the Silver Bow Basin, back of the town of Juneau

ALASKA-JUNEAU MINE, SILVER BOW BASIN.

on the mainland, where are located the Ebner, Alaska-Juneau, and Perseverance quartz mines, as well as some hydraulic diggings in the basin proper; on Silver Bow Creek; on Eagle River, and in Berner's Bay, on the Jualin mine. The Treadwell group of mines are to the Juneau district what the Homestake group are to the Black Hills. In the latter, there are in addition the Golden Reward group and a few other producing mines, so in the former we find the Jualin, the Eagle River, and the Ebner mines today producing practically all the bullion outside of that produced by the Treadwell group. In the near future the Alaska-Perseverance mine situated at the head of Silver Bow Basin, and the Greek Boy on Berner's Bay, will be added to the present producers.

One of the most interesting features connected with the Juneau mining district is the method of mining employed underground in the Treadwell group, where no attempt at timbering in the stopes is made, notwithstanding the fact that these are upwards of 200 feet wide and 1,000 feet long.

MILL SITE, ALASKA PERSEVERANCE MINE, SILVER BOW BASIN.

In opening a new level a drift is driven along the strike of the ore body, and every 60 feet along this drift an upraise is made 20 feet in height, which is timbered and later serves for a chute to discharge ore from the stopes above into the cars. From the top of these upraises stoping is started and extended in every direction except downwards; the machine drills are set on the broken ore, of which fully two-thirds is always kept in the stopes, until the entire body of ore between two levels, except the 20 feet left above the drifts, is stoped out. In addition to leaving this horizontal body of ore there are several vertical pillars left in the stopes, through which at regular intervals are driven man holes, by which method miners can obtain ingress and egress between the various chambers in the stopes. By working in this way the cost of timbering is eliminated, and by leaving two-thirds of the broken ore and the vertical pillars until the ore body is stoped out between the levels, a factor to insure safety from caving has been introduced.

EBNER MINE, SILVER BOW BASIN, JUNEAU DISTRICT.

Eventually it is proposed not only to stope out the vertical pillars, but also the 20 feet of ore left above the drifts. When this is done the entire workings will present the same appearance, only on a much more extensive scale, as the Glory Hole does at the present time. The dimensions of this are about 270 feet in depth, about 300 feet in width, and some 800 feet in length.

The high-grade ore mined in the Eagle River and the Jualin Mines last season has proved a strong incentive not only to prospectors, encouraging them to explore the country more thoroughly, but to the owners of partially developed prospects and idle mines, leading them to renewed efforts to persuade capitalists to invest. When such results accrue from systematic development as was the case in the Jualin

Mine on Berner's Bay—where late in the season the apex of a new ore body was exposed in a drift and proved to be 350 feet in length, the ore from it yielding in free gold on the plates and in the batteries $25.00 per ton, in addition to the values carried by the concentrates—owners of other properties in practically the same geological formation certainly have cause to feel that capital judiciously invested may result in placing mines idle today among the list of producers tomorrow.

As a matter of fact, in the case of the Jualin Mine, the owners, on the advice of the superintendent (Mr. W. W. Hoggatt) had arranged for the expenditure of capital in development during this season, but to their agreeable surprise the ore body they were seeking was exposed when the season was about half expired, and the ore proved to be of considerable higher values than the owners had anticipated.

THE TREADWELL MILL AND MINE.

Prince William Sound District.—To the north-westward from the Juneau district no metal mining is being done between Berner's Bay and Ellamar, in Prince William Sound. The earliest discoveries on Prince William Sound were the Gladhaugh mine at Ellamar and the property known as the Beatson mine on La Touche Island. Both of these properties have been shipping copper ore, much of it carrying in the neighborhood of 10 per cent copper per ton, for the past two years. The tonnage shipped by the Gladhaugh has been from stop-

ing from the various levels to a depth of 500 feet, but the ore shipped from the Beatson mine has been principally the quantity removed in doing development work. This property is phenomenal in several respects. Exploitation through a cross-cut tunnel at a depth of some 200 feet below the apex of the outcrop has demonstrated that the ore body is about 200-feet wide, of which width some 35 feet carries exceptionally high-grade copper ore while the average of the balance of the ore body is about 5 per cent in copper.

IN THE PIT, TREADWELL GOLD MINES, ALASKA.

The outcroppings on this property are chiefly found in a bold bluff, almost immediately over the cross-cut tunnel, and the ore body has been traced along the surface for a considerable distance in both directions from this bluff. During the summer season a considerable tonnage of shipping ore is quarried from the face of the bluff, but no ore is stoped down from above the cross-cut tunnel in the underground workings. A second tunnel is being driven at a level about 100 feet below the one already referred to. When this tunnel intersects the ore body it will be made the main working tunnel, and all ore will be trammed through it to the bunkers on the wharf, about a quarter of a mile distant.

The visitor to the Beatson property on La Touche Island cannot help but be very favorably impressed not only with the property itself but also with the surroundings, for no expense has been spared to

make all the buildings as substantial and as comfortable as are those in any of the older mining camps. Evidently the comfort of his workmen has been one of the main considerations taken into account by Mr. Beatson the manager.

Although there are no other regularly shipping mines at present in this district, yet there are several very promising prospects on Landlock Bay, Fidalgo Bay, Boulder Bay, Orca Bay, and on the mainland within a few miles of Valdez, the supply centre, situated at the head of Prince William Sound.

In the interior from Valdez some 160 miles or so are situated the Copper River occurrences of chalcocite, bornite, and other copper ores which have during the past few years attracted so much attention that at the present time a railroad company is preparing to construct a line into the Copper River district.

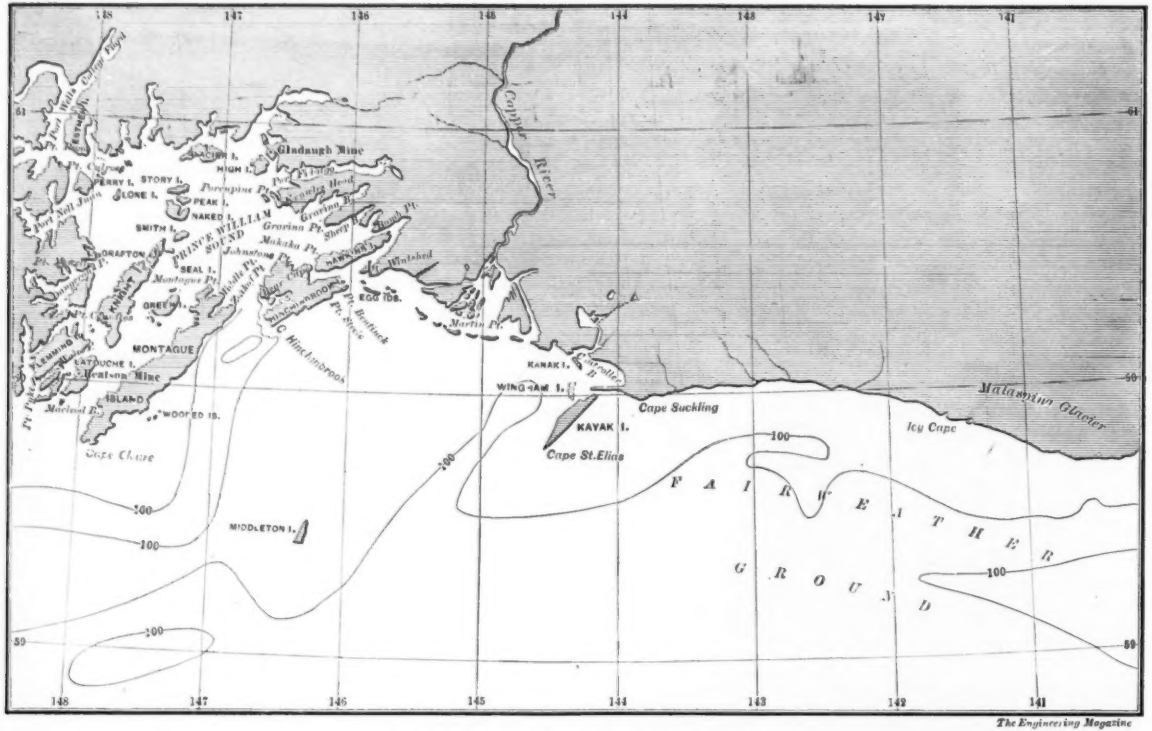
Kenai and Alaskan Peninsula Districts.—To the westward from Prince William Sound along the coast several very promising prospects have been located, some near Seward, the southern terminal of the Alaska Central Railway, others at Port Dick and Port Chapman, near the easterly side of the entrance to Cook's Inlet, and still others

GLADHAUGH COPPER MINE, ELLAMAR, ALASKA.

SEWARD, ALASKA, SHOWING THE TRACK OF THE ALASKA CENTRAL RAILWAY CONNECTING THE WHARF WITH THE TOWN.

in the vicinity of Illiamna Lake on the western side of this entrance. The ore occurring on these prospects is a copper-gold sulphide, carrying (it is claimed) high values, but on none of the prospects has there yet been sufficient work done to warrant an estimate of tonnage of ore in sight. Indeed, during the last season the first really earnest, systematic development work has been performed.

Prospectors during 1904 carried their explorations in search of copper-gold ores to the westward as far as Kadiak Island, and some locations were made; but owing to the remoteness and consequent difficulties in transportation, there being only one boat a month direct from Seattle, the owners of these prospects have found difficulty in



The Engineering Magazine

A PART OF THE MIDDLE ALASKAN COAST.
From the chart of the Coast and Geodetic Survey.

LANDLOCK BAY, PRINCE WILLIAM SOUND, ALASKA.

interesting capital; for this reason assessment work only has been performed.

The building of the Alaska Central Railroad from Seward is proving to be an encouragement to prospectors to explore the country along its route. This has resulted in the location of several gold-bearing quartz claims in the vicinity of Kenai Lake, some twenty miles from the town of Seward. Several very fine specimens of quartz showing free gold were brought out from this section late in the season, and the probabilities are that some systematic development will be attempted this year.

An occurrence of copper-gold known as the Ready Bullion group of mineral claims is situated some sixteen miles from the proposed line of the Alaska Central Railroad, on Turnagain Arm at the head of Cook's Inlet. During the season of 1905 considerable development work was performed on this property, with the expectation of blocking out ore ready for shipment when the railroad is completed sufficiently near to warrant building a branch to this property.

The vicinity of Turnagain Arm has been the scene of considerable placer and hydraulic mining since 1897, and every year some three or

PRINCE WILLIAM SOUND, NEAR THE ENTRANCE TO LANDLOCK BAY.

four hundred men have been employed in this industry. During 1904 and 1905 several companies took in heavy machinery for hydraulic mining, and during the present season these companies should be in a position to demonstrate whether or no their operations will result in commercial success.

This portion of Alaska has been handicapped in the past because of transportation difficulties. A 52-foot tide is not an unusual occurrence on Turnagain Arm; consequently navigation, especially in small boats such as are used by prospectors, is hazardous in the extreme, but with the advent of the Alaska Central Railroad into this portion of Alaska many of these transportation difficulties will be overcome.

The coal mining and prospecting for oil industries are carried on on the mainland near Kayak Island; also on the Kenai Peninsula and near the coast on Illiamna Bay; but owing to the remoteness of the districts the coal mines have not yet reached the point of production on a commercial scale, nor has any oil been shipped.

That portion of Alaska along the coast westward from Sitka undoubtedly possesses great wealth in mineral resources which will in the near future be developed to a point that will insure commercial success to many of the operators.

INDUSTRIAL DEPRESSIONS, AND ENGINEERING EXPORT AND IMPORT TRADE.

By W. Pollard Digby.

"There . . . . goes England's commercial prosperity." The Devil's Thoughts.—S. T. Coleridge.

The problem of the causes of great fluctuations in national prosperity is one of perennial importance, and Mr. Digby's graphic methods of examination are well worth following, at a time especially when the two greatest manufacturing countries—America and England—present extraordinary contrast in the point of industrial exaltation or depression.—THE EDITORS.

IT is perhaps questionable whether a writer on a statistical or economic subject should use as a prelude to any writings on subjects of gravity and far-reaching importance, any such preface as that which has been selected in the present instance. Its very appositeness seems so appropriate to the subject that, despite the unconventionality of the procedure, I have annexed it to serve very much in the nature of an illustrative text, or comment, on a popular and recurring interpretation of the statistical history of an important section of the industries of the arch manufacturing country of the world. The trite saying cited has been repeated—in effect, if not in identical wording, in each of the recurring depressions which have afflicted British industries. This quotation from a crude piece of doggeral semi-political, scathingly sarcastic, but soundly humanitarian in one stanza, has been preserved for posterity like a fly in amber only by reason of the abiding worth of Coleridge's other more valuable contributions to our literature. That British commerce is in a parlous condition, that like the pig drifting down the stream in the squib referred to, it is cutting its own throat, has been told in effect to us and to our forefathers with such reiteration that the British manufacturer is apt to become sceptical of oft-repeated warnings of impending disaster.

At the nadir of each cycle of depression, it is acclaimed that never were matters so alarming. The effect of this pessimism on a large population who do not trouble to go deeply into any such question as economic history, is enhanced to a very large extent by the advocates of numberless practices and policies. The educational reformer, the temperance advocate, both of whom preach more or less fruitlessly in a time of prosperity, find, in a time of depression, both an

example and listeners. Here also is the opportunity of the demagogue and agitator. We are told, in effect, by disinterested and interested advisers alike, that hardly ever were matters so bad, and never was the future so dismal. To a small extent houses are set in order, extravagances are checked, methods of manufacturing are improved. Trade flows again in its old channels or in new, in a volume greater than before. Then the familiar features of prosperity manifest themselves—extravagance, over-production, reduced employment, perhaps a few bad harvests—and again the voices of the physician and of the quack, of the philosopher and of the mountebank, are heard in the land. If, ere the zenith of a trade cycle was attained, attention were paid to our more glaring defects of education, and to improving commercial methods generally, the subsequent period of depression would probably be less serious in its effects, although, of course, not entirely eliminated.

I have been led to compile the following notes by reason of the fact that in connection with the Protectionist movement undue emphasis is laid on exports and imports. Diminishing or stationary exports, together with increasing imports, are regarded as taking the bread out of the mouth of the artizan by the foreign manufacturer. If this state of affairs were as true as its narrators would wish their hearers to believe, we should expect to find the following phenomena:—

1.—With an increase in the exports of any particular industry the number employed in the industries concerned should increase; that is to say, the percentage of unemployed should be reduced *in proportion to the increase in exports.*

2.—With an increase in the imports of any particular industry, the number employed in the industries concerned should decrease; that is to say, the percentage of unemployment should be increased *in proportion to the increase in imports.*

Unless both these theorems are vindicated by the figures in the large majority of instances, they are surely untenable and should no longer be advanced by any participants in the present fiscal controversy.

In common with all other students of the fiscal question, I have found much of instruction and interest in the two "enquiry" blue books on "British and Foreign Trade and Industrial Conditions" (Nos. Cd. 1761 and Cd. 2337). The second of these publications gives an invaluable record of the course of employment in the United Kingdom for a number of years. The statistics of employment fur-

nish a useful test "of the fluctuations of industry as a whole, inasmuch as they measure the relative activity and depression of the whole of the industries to which they relate, including production for the home market as well as for export." These statistics are therefore an index to two books; the one, compiled with great care and elaboration, deals with external trade, with a microscopic detail which enumerates commercial transactions of imperial importance, such as the imports of £10 worth of calcium carbide from the United States, or £3 worth of gum arabic from Victoria, or exports of steel girders to Queensland valued at £17, or sugar candy valued at £20 to the Bermudas or £5 worth of safety matches to Bombay.

The other book is an unwritten one, and, being unwritten, the state of affairs which it would narrate is often regarded as non-existent. Certain factors in import returns—such as imports of iron ore, or raw cotton, or wool—indicate to a partial extent the contents which the unwrittetn volume might contain. In its ideal form it would contain an account of the number of hands employed in each clearly defined industry, the amount of wages paid to them, the value of machinery, building, and site, the value of raw material dealt with, and the value of the finished output. Present statistics of railway traffic, savings-bank returns, and so forth, would be included. As a contribution to a settlement of the fiscal question, the contents of supreme importance would be those dealing with the consumption of raw material, and the output of finished articles. By balancing exports and imports of any particular class, and allowing for goods warehoused, an exact national balance sheet would be available so far as that section of industry was concerned. The solution of one aspect of the fiscal question would then be a matter of almost arithmetical simplicity—a simplicity which would appeal to the man in the street who, on the one hand, mistrusts brilliant metaphysical reasonings, and, on the other hand, cares as much for the elements of political economy as he does for the conservation of energy or the Carnot cycle. To the plain man wanting plain figures, statistics which contrasted exports and imports of a particular industry with the value of the home output, would show at once how far home industries were being ruined by dumping from abroad.

Among the staple British industries declared to be threatened are those of the engineering trades. Such announcements do not take into consideration the elementary facts which may be obtained from census abstracts on the one hand, and statistics of pig iron on the other. Let us look at a few data:—

Census Year.	Number per 10,000 of population engaged in iron and steel industries, and in producing manufactures thereof.	Production of pig iron per 1,000 employees in entire industry.	Consumption of pig iron per 1,000 employees in entire industry; production plus imports, minus exports, divided by number of employees.
1881	239	9,765	8,052
1891	257	7,730	6,827
1901	301	6,348	5,832

It happens by a singular chance that the census years happen to be years in which the general percentage of unemployment for all unions in the engineering, shipbuilding, and metal trades was about equal, being as follows:—

1881 3.8 (reckoned from monthly numbers of unemployed).
1891 4.4 (" " " " " ").
1891 4.1 (partly computed from expenditure on unemployed benefit).
1901 3.8 (" " " " " ").

While the percentages of total unemployment in the engineering trades remained constant, the number of artizans so engaged had increased more rapidly than the population as a whole. Yet the production of pig iron per 1,000 employees has declined by over 30 per cent, and the consumption by nearly 30 per cent, in twenty years.

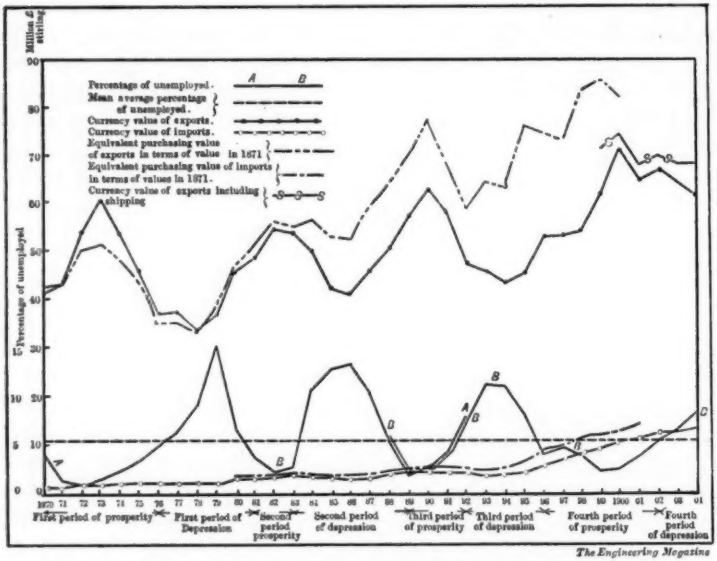
The foregoing figures are surely sufficient proof that the artizans engaged in these engineering industries are being diverted from the lower grades of work (23 per cent of the cost of pig iron being wages outlay in its conversion from ore to pig) into the more highly skilled branches of employment such as shipbuilding, in which the wages outlay in the shipyard is from 33 per cent to 40 per cent of the cost of the ship. There are those who contrast a stagnation of British pig-iron production with the notable increase in Germany and American production. These contrasts are made in ignorance—pretended or real, but certainly inexcusable—of the application to deposits of mineral wealth of the adage respecting eating one's cake and having it. We have had repeated scares regarding the duration of British coal supplies, and two Royal Commissions have reported reassuringly on the subject. As regards iron-ore, imports have grown without public perception or perturbation. Deposits of high-grade ore in readily accessible positions had gradually become exhausted. British capital found other sources in the Biscayan Provinces of Northern Spain, organized steamship services, and the state of affairs which resulted, is indicated in the following figures:—

Average for five years ending	1877.	1882.	1887.	1892.	1897.	1902.
Tons of ore imported into the United Kingdom per 100 tons of pig iron produced.....	12.4	27.7	40.2	50.2	61.2	70.7
Tons of ore imported into the United Kingdom per 100 tons of pig iron exported.....	78.2	129.6	262.6	388.6	507.8	544.0

The British iron industry, in stress of competition with other countries such as Germany, Belgium, and the United States, which had not drawn so largely on their ore reserves, evolved into an industry on a higher plane, purchasing semi-finished products from abroad, converting them into more highly finished goods of greater value. Great Britain thus finds more employment for her growing population by converting one ton of imported iron or steel into goods of greater value, than by making and exporting one ton of the crude material which, being the finished article of blast furnaces, is the raw material for other industries.

In considering the relation which exists between engineering imports and exports and the percentage of unemployment in the engineering industries, the question arises as to what should be selected as the initial year of computation. As the period of the early seventies has been often regarded as the golden era of British commercial supremacy, it is perhaps better to take 1870 as the starting point. The exports whose totals are indicated in the accompanying diagram comprise:—railway rolling-stock, electric-lighting apparatus and machinery, hardware and cutlery, sewing machines, steam engines, machinery and millwork of all descriptions, iron and steel in various form from bolts to tinplates, from girders to steel rails, from anchors to galvanized corrugated sheet. Copper and other metals are included. The imports are not so diversely classified, and the title "Total value of iron and steel imports and machinery" serves to indicate their scope. Their extent remained practically stationary over a long period, rising into prominence only during the past decade or so. From these exports iron ore has been excluded, for the obvious reason that none would question its being a raw material. On the same account copper (ore precipitate and regulus, as well as wrought and unwrought copper) pig and sheet lead, block, ingot bar and sheet tin, as well as crude and manufactured zinc, are also excluded. A purist with regard to classifications would justly catalogue a large number of the iron and steel imports as raw material. For instance, pig iron, which is the finished product of the blast furnace, is the raw material of the steel founder; steel billets, ships' plates, steel forgings, and other materials are but intermediate links in the manufacture of goods from a low to a higher stage. The finished product of one section being the raw material for other sections, the drawing of a dividing line is an impossibility, and the best description of these imports would be to describe them as finished and semi-finished.

As regards the condition of employment, the figures from the


Million £ sterling
Percentage of unemployed.
Mean average percentage of unemployed.
Currency value of exports.
Currency value of imports.
Equivalent purchasing value of exports in terms of value in 1871
Equivalent purchasing value of imports in terms of values in 1871.
Currency value of exports including shipping
A
B
Percentage of unemployed
First period of prosperity
First period of Depression
Second period prosperity
Second period of depression
Third period of prosperity
Third period of depression
Fourth period of prosperity
Fourth period of depression

The Engineering Magazine

TRADE DEPRESSIONS IN RELATION TO ENGINEERING EXPORTS AND IMPORTS.

second "Enquiry" blue book concerning the percentage of unemployment in the engineering, shipbuilding, and metal trades are taken as the standard. These cover only total want of employment, and not the partial lack of employment due to working short time. A glance at the accompanying diagram shows that the occasions of rising exports, reckoned in their currency value in pounds sterling, coincide fairly closely with a fall in the percentage of unemployed, and that the contrary state of affairs is manifested when exports are reduced in volume, as then the percentage of unemployed increases. Starting from 1870 we find a fall in the percentage of unemployment until 1872; the previous flood mark of depression had been in 1868. In 1873 the percentage of unemployment began to rise, and this rise continued until 1879, when the serious percentage of 15.3 was recorded. The number out of work then fell to 2.3 in 1882, and, turning again, rose to 13.5 in 1886, receded to 20 in 1889, rose to 11.4 in 1893, fell to 2.4 in 1899, and rose without set back to 8.8 for 1904.

If we were to take these turning points in the ebb and flow of employment as being the starting points of periods of prosperity or privation, we should not obtain a fair delimitation of these periods. If we take a period of increasing employment, such as that between

1894 and 1899, our next period of decreasing employment would contain the years 1900 and 1901, in each of which (although employment was decreasing) the percentage of unemployed was less than 1898. The fairest course will therefore be that of taking the arithmetical mean for 1870 to 1903 inclusive, and treating as periods of prosperity those in which the percentage of unemployment was below the average, and as periods of depression those in which the percentage of unemployment is equal to or above the average. For the engineering trades, this average during the thirty-four years mentioned stands at 5.6 per cent. This gives us the following classification:—

(a)	First period of prosperity lasting until the end of	1876—7	years.
(b)	First period of depression " " " " "	1880—4	"
(c)	Second period of prosperity " " " " "	1883—3	"
(d)	Second period of depression " " " " "	1888—5	"
(e)	Third period of prosperity " " " " "	1891—3	"
(f)	Third period of depression " " " " "	1895—4	"
(g)	Fourth period of prosperity " " " " "	1901—6	"
(h)	Fourth period of depression continuing at end of 1904 and covering up to that date.....	3	"

The accompanying diagram gives at a glance the value of imports and exports expressed in their currency and equivalent purchasing values in each year, together with the percentage of unemployed in the engineering trades unions in each year. The following table shows the relation between unemployment, the currency value of imports and exports, and the relative purchasing value during each of the eight periods defined above:—

	Period (inclusive years).	Character.	Average percentage unemployed.	Average annual currency value of engineering exports.	Average of equivalent purchasing value of exports based on prices ruling in 1871.	Average annual currency value of imports of iron and steel machinery.	Average of equivalent purchasing value of imports based on prices ruling in 1871.
				£	£	£	£
a.	1870-76	Prosperity	2.7	48,549,000	44,951,000	2,045,000	1,906,000 p.
b.	1877-80	Depression	9.3	38,907,000	39,312,000	2,871,000	2,904,000 d.
c.	1881-83	Prosperity	2.9	52,758,000	54,458,000	3,895,000	4,036,000 p.
d.	1884-88*	Depression	9.8	46,361,000	57,698,000	3,546,000	4,288,000 d.
e.	1889-91	Prosperity	2.9	59,723,000	72,685,000	4,484,000	5,433,000 p.
f.	1892-95	Depression	9.3	47,206,000	61,595,000	4,098,000	5,368,000 d.
g.	1896-1901	Prosperity	3.6	60,009,000	79,678,000	8,842,000	11,833,000 p.
h.	1902-1904	Depression	6.8	64,507,000	.....	.....	.....

While currency values provide in some cases a fairly accurate

* The year 1888 marks a change in method of computing percentage of unemployment. On the old basis this would have been an average year, but on the new basis of computation, the percentage is in excess of the average.

basis for comparing consecutive years, to make use of these in contrasting periods widely separated is an impossible procedure for those setting any store on accuracy. Even to compare the currency value of exports of pig iron in 1871 with those of 1873 would be entirely fallacious, as in the latter mentioned year the price received was double that in 1871. I have therefore fallen back upon the Board of Trade index numbers of forty-five chief articles of commercial value, and taking the purchasing value of the pound sterling in 1871 as 1.00, have expressed the relative values of the exports and imports dealt with in terms of the purchasing value ruling in 1871.

In the first period of prosperity the average percentage of unemployed stood at 2.7, and the average annual currency value of exports at £48,549,000. In equivalent purchasing value on the 1871 basis the average annual exports would be worth £44,951,000. The average imports were worth in currency £2,045,000, and in purchasing value £1,906,000. The first period of depression had an average percentage of employment of 9.3, and export currency value of £38,907,000. A large currency fall of £9,500,000 was masked by the general fall in the prices of commodities, the relative purchasing value standing at £39,312,000, or rather over £5,500,000. The second period of prosperity had an average percentage of unemployment of 2.9, a currency increase of exports of nearly £14,000,000, to £52,758,000, and purchasing-value increase of over £15,000,000 to £54,458,000. Imports rose as regards their currency value to £3,895,000, and as regards their purchasing value to £4,036,000. The second period of depression was marked by a rise in unemployment to 9.8 per cent and a fall of £6,500,000 in the currency value of the engineering exports to £46,361,000. The currency value of the imports fell to £3,546,000. So great, however, was the fall in the value of commodities generally, that the relative purchasing value of the imports rose to £4,288,000. The next period of prosperity—the third in the period under review—was marked by the return of the percentage of unemployment to 2.9, and by the great increase in exports, which had an average currency value of £59,723,000, and a relative purchasing value of £72,685,000. The imports rose as regards their currency value to £4,484,000, and as regards their purchasing value to £5,433,000. The third period of depression had an average percentage of unemployment of 9.3, and a fall of £12,500,000 to £47,206,000 in the currency value of the exports, while their purchasing value fell £11,000,000 to £61,595,000. Imports fell by about 10 per cent in currency value to £4,098,000, but only by about 1 per cent in relative

purchasing value, to £5,368,000. The fourth period of prosperity had an average percentage of unemployment of 3.6, and a rise of about £12,750,000 in the currency value of exports to £60,009,000. More remarkable is the rise of £18,000,000 in the purchasing values of these exports to £79,678,000. Imports rose to the high figure of £8,842,000 sterling in their currency, and to £11,833,000 in their equivalent purchasing value.

As regards the fourth wave of depression the figures are at present incomplete. One hopes that it has reached its worst feature, and present indications seem to point in this direction. The unemployment curve has not yet taken the desired downward trend, but judging from previous precedent it may fall from its high figure of 8.8 per cent in 1904 to a figure below the mean average line which I have arbitrarily taken as defining a border between prosperity and depression. One feature of the last period may be noticeable, and that is that while exports are slightly lower than the high-water mark of the previous period, the average for the past three years—although of increasing unemployment—is in excess of any previous period. Imports have remained practically stationary.

Reviewing the facts which have been elucidated by my figures, and which are illustrated in the accompanying diagram shewing the fluctuations in individual years, and in the preceding table which gives the average in the four sets of alternate periods, we find that:—

1.—In periods of depression, exports fell three times and rose on one occasion in their currency values; exports fell twice in their relative purchasing values, and rose on two occasions; and in periods of prosperity exports rose on each occasion as regards both currency and purchasing values.

2.—In periods of depression, imports rose on only one occasion in their currency values, fell twice and once remained practically stationary; rose twice in their purchasing values, remaining almost stationary twice; and in the periods of prosperity, imports always rise in regard to both their currency and purchasing values.

That is to say, that the two theorems which would require to be vindicated by the facts of the case are only partially vindicated by an examination of the figures of trade to which the ultimate appeal must be made. The reduction of particular classes of imports, which (it is asserted by unthinking advocates of a changed fiscal system, is all that is wanted to give universal satisfaction) would be of little real value to the engineering industry as a whole.

Of course, changes in the rate of employment are not bound up

inseparably with external trade. The unchronicled and dimly realised volume of internal trade dependent upon home and foreign harvests of grain, dependent partly on rainfall in pastoral countries, on yield of wool, or raw cotton—all these are forces bearing upon the employment afforded in the engineering trades. There are also indirect engineering exports to be considered, such, for instance, as the cotton trade, whose export trade consists in the working up of imported raw materials, the receipts from which, after paying for raw material, have to cover wages to the operatives and wear and tear on machinery. These all have their bearing in the alternating waves of trade cycles, with their recurring times of surplus and scarcity.

An absolute elimination of periods of depression and prosperity is impossible. Nature from the opening bud to the flowing spring and neap tides, which occasion variations in the strata of the sediment deposited at our river estuaries, knows nothing of a straight-line law of operation. As the late Herbert Spencer has shown, rhythm prevails through all known forms of motion or progress. In the currents of commerce it (a backward and forward movement) "is especially conspicuous." "If . . . we turn to production and consumption we see undulations, much longer in their periods, but almost equally obvious. Supply and demand are never completely adapted to each other; but each of them from time to time leads presently to an excess of the other." Concluding a striking and suggestive chapter, Mr. Spencer* says, "Rhythm is a necessary characteristic of all motion. Given the co-existence everywhere of antagonist forces—a postulate which, as we have seen, is necessitated by the form of our experience—and rhythm is an inevitable corollary from the persistence of force."

The preceding chapter to that just quoted may be commended to all who imagine economic questions, such as the present fiscal controversy, can be solved by an enumeration of two phases of the case and assuming that these are the only factors involved.

Exports and imports are only a manifestation of the influences which bear upon our trade, both external and internal, directing it into one channel or another, or limiting a continuous expansion. Fluctuations are as inevitable as the seasons. To treat the economic question of lack of employment as summed up by a dumping of foreign goods, or a restricted access to foreign markets, and dirigible by tariff impositions, is to invest an intricate problem with an air of spurious simplicity, fraught with grave danger on account of its speciousness and superficiality.

* First Principles, by Herbert Spencer, 5th Edition, p. 267.

CEMENT PRODUCTION AND MANUFACTURE IN THE UNITED STATES.

By Edwin C. Eckel.

The enormous rise in the per capita production and consumption of iron and steel has very recently been the subject of striking—indeed, almost sensational—comment. Proportionately little attention has been given to the even more enormous rise in the output of cement. Mr. Eckel lately sketched the principal outlines of this movement (see this Magazine for November, 1905) and now parallels his discussion of the American steel trade, which appeared in our last number, with a more detailed study of this companion and closely related industry.—THE EDITORS.

PERHAPS the most striking feature of the engineering and architectural practice of the present day, as compared with earlier work, is the extent to which steel and cement are employed, either together or separately, as structural materials. The general use of these two materials for such purpose is largely a matter of the past two decades, while some of their most striking utilizations have been determined only within a few years.

The growth of the steel and cement industries has of course paralleled the recent large extensions in the use of the finished products. In a recent number of this Magazine I have discussed the iron and steel industries in their general economic relations, while the present article will be devoted to the cement industry. Comparison of the two sketches would show a very remarkable—but very natural—parallelism between the periods of prosperity and depression in the two industries. This parallelism, of course, has been shown only during recent years, for the iron and steel industries date back to very remote periods in the history of the race, and have occupied an important economic position for many centuries.

In this connection it must be recalled that cements which will set under water are comparatively new products, having not much over a century of recorded use to their credit. Notwithstanding occasional statements to the contrary, the ancients had no knowledge of true hydraulic cements. Analyses of mortar material used in the construction of the Pyramids shows that it was composed of calcined gypsum, or plaster of Paris; and many other ancient mortars are of this type, being plasters rather than cements. Ordinary lime mortar, of course, has been in common use since very early days, and many of the

famous Roman works were constructed with a mortar which an engineer of to-day would hesitate to use. Such common lime or "quicklime" is made by burning a pure limestone at comparatively low temperatures, just sufficient to drive off the carbon dioxide which it contains. The resulting product—quicklime—will slake violently if water be added to it, and when thus mixed with water and sand becomes the ordinary lime mortar of the builder.

Until late in the eighteenth century it was supposed that the purer, the limestone, the stronger the resulting mortar. About 1795, however, French and English engineers, working independently, found that when a very clayey impure limestone was burned a very interesting product was obtained. This new material was a true hydraulic cement, for unlike quicklime the burned lumps did not slake on the addition of water, but when ground up finely and then mixed with water the mortar possessed hydraulic properties— i. e. it would "set" or harden under water.

Natural Cements.—Cements made in this fashion, by merely burning a naturally clayey limestone and grinding the resulting lumps, are known as natural cements. Under the names of Parker's cement, Roman cement, etc., such natural cements soon became widely manufactured and used in England and on the Continent. In the United States they were first made in 1819, in New York State, and were extensively used in the construction of the first Erie Canal. The manufacture soon spread over the country, the incentive to this rapid adoption of a new industry being the necessity for using a hydraulic mortar in the locks and walls of the many canals then under construction. The various American natural cements are generally known to engineers by the name of the locality at which they are manufactured, as Rosendale cement, Akron cement, Fort Scott cement, Utica cement, etc.

The American natural-cement industry has shown very slight gains in annual output during the past decade, and at present is almost stationary. During the eighty-five years of its existence, however, the total amount of natural cement produced in the United States has been very large, and even now the industry can hardly be considered as being beyond hope. Improved methods of manufacture, and greater care on the part of the managers and chemists, would go far toward placing it on a thoroughly sound footing.

The localization of the natural cement industry in certain parts of the United States is well brought out in the following table. It will be seen that New York, the birthplace of the industry, still retains first rank, though by a steadily lessening margin.

State.	1902. Number of works.	1902. Quantity.	1902. Value.	1903. Number of works.	1903. Quantity.	1903. Value.	1904. Number of works.	1904. Quantity.	1904. Value.
		Barrels.			Barrels.			Barrels.	
Ga. ...	2	55,535	$31,444	2	80,620	$44,402	2	66,500	$37,750
Ill. ...	3	607,820	156,855	3	543,132	178,900	3	360,308	113,000
Ind. ..	15	1,727,146	869,163	15	1,533,573	766,786	13	735,906	367,953
Ky. ..							2	264,104	132,052
Kan. .	2	160,000	80,000	2	226,293	169,155	2	210,922	79,456
Md. ..	4	409,200	150,680	4	269,957	138,619	4	65,000	32,500
Minn. .	2	150,000	67,500	2	175,000	78,750	2	138,000	65,620
N. Y..	19	3,577,340	2,135,036	20	2,417,137	1,510,529	19	1,911,402	1,138,667
N. Dak.	1	.....	.....	1	.....	.....	1	*a*	*a*
Ohio .	2	.....	.....	2	67,025	46,776	1	*b*	*b*
Pa. ..	6	796,876	340,669	7	1,339,090	576,269	5	770,897	298,533
Tex. .	1	.....	.....	2	.....	.....	1	*c*	*c*
Va. ..	2	34,000	20,000	2	47,922	25,961	2	93,292	59,619
W. Va.	1	88,475	62,655	1	.....	.....	1	.....	.....
Wis. ..	2	437,913	162,628	2	330,522	139,373	2	250,000	125,000
Total	62	8,044,305	4,076,630	65	7,030,271	3,675,520	61	4,866,331	2,450,150

The annual production of natural cement in the United States for the years 1890 to 1904 inclusive, was as follows:

	Barrels.
1890	7,082,204
1893	7,411,815
1895	7,741,077
1897	8,311,688
1898	8,418,924
1899	9,868,179
1900	8,383,519
1901	7,084,823
1902	8,044,305
1903	7,030,271
1904	4,866,331

This table is of particular interest when compared with a similar one, presented on the following page, giving the production of Portland cement for the same years.

Portland Cement.—The agency which has had most influence in checking the growth of the natural-cement industry has been the remarkable development of the manufacture of Portland cement. First made in England in 1824, and named because of the resemblance of the set cement to a well-known English building stone, the industry soon became important in England, France, and Germany. Until about 1875, however, practically no attempt was made to manufacture Portland cement in the United States; and from 1875 to 1890 the new industry grew quite slowly. From that date on, however, and

a Included with Minnesota. *b* Included with Virginia. *c* Included with Kansas.

particularly since 1895, its growth has been surprisingly rapid. This is well shown in the following table, which gives statistics of the American production of Portland cement for the years 1870 to 1905 inclusive.

TOTAL PRODUCTION OF PORTLAND CEMENT IN THE UNITED STATES.

Years.	Plants.	Barrels.	Value.
1870-1879	..	82,000	246,000
1880	..	42,000	126,000
1881	..	60,000	150,000
1882	..	85,000	191,250
1883	..	90,000	193,500
1884	..	100,000	210,000
1885	..	150,000	292,500
1886	..	150,000	292,500
1887	..	250,000	487,500
1888	..	250,000	487,500
1889	..	300,000	500,000
1890	16	335,500	704,050
1891	17	454,813	967,429
1892	16	547,440	1,153,600
1893	19	590,652	1,158,138
1894	24	798,757	1,383,473
1895	22	990,324	1,586,830
1896	26	1,543,023	2,424,011
1897	29	2,677,775	4,315,891
1898	31	3,692,284	5,970,773
1899	36	5,652,266	8,074,371
1900	50	8,482,020	9,280,525
1901	56	12,711,225	12,532,360
1902	62	17,230,644	20,864,078
1903	71	22,342,973	27,713,319
1904	79	26,505,881	23,355,119
1905	82	31,000,000	29,000,000
Total.....		138,114,577	$153,660,717

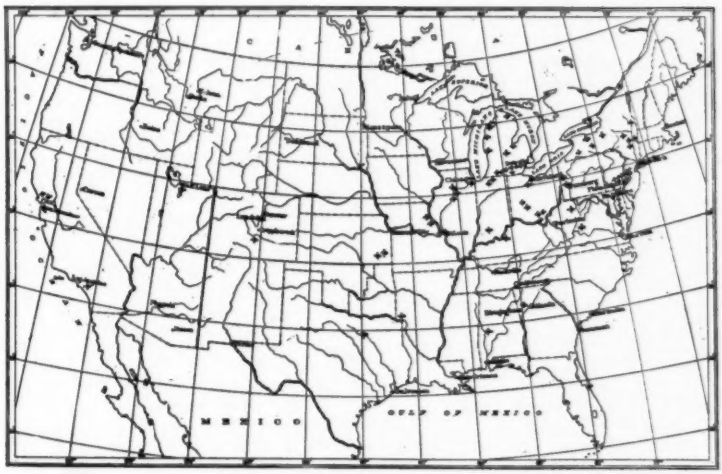
The detailed statistics for 1905 are, of course, not obtainable at this date, so that the figures given for that year in the above table represent merely my own estimate as to quantity and value of production. I believe that my estimate, if wrong, errs in being too conservative. The immense output of our mills for the last few months of 1905 may carry the total production for the year considerably higher than the 31,000,000 barrels which I have allowed. However the final figures may turn out, it is certain that the 1905 total is by far the largest ever shown by the American cement industry—and this in spite of a distinctly bad start for the year. Last winter most of the mills carried over large stocks, and the low prices which this caused in the spring had the effect of discouraging production. Late in the spring, however, the cement trade caught the same advance that made such an impression on the iron industry, and this condition lasted with little interruption until the present date. The year 1906 opens with practically every mill

in operation at its full capacity, and with new mills being rapidly pushed to completion.

The materials used in Portland-cement manufacture are limestone and clay, in some of their many forms. These are mixed in proper proportions, the mixture is finely ground, and then burned almost to a slag, after which the semi-fused product or clinker is reduced to extreme fineness. This outline may seem simple, but the process is in reality one of extreme delicacy, requiring the greatest care throughout in order to insure a satisfactory product.

The idea seems to be commonly held that deposits of raw material suitable for Portland-cement manufacture are of extreme rarity, and therefore of great value. As a matter of fact, such materials are very widely distributed throughout the United States, and many other factors besides good raw materials have to be considered in deciding on the location of a plant.

Attention may here be called to a feature of particular economic interest—the utilization of the waste-products of other industries as materials for the manufacture of Portland cement. Among the by-products which have been successfully used in this manner are included blast-furnace slag, alkali waste, and the waste slate from quar-



MAP SHOWING DISTRIBUTION OF PORTLAND-CEMENT PLANTS IN THE UNITED STATES.

Except in southern Michigan and south-eastern Pennsylvania, each cross represents a single factory. In the two districts named the plants are too closely grouped to be shown separately.

ries and slate-dressing mills. Of the three named blast-furnace slag is of course the most important, and its successful utilization as a Portland-cement material is worthy of particular attention. The Clinton Iron and Steel Co. of Pittsburg first used it for this purpose, followed within a few years by the Illinois Steel Co. at Chicago. The latter plant has been so successful that it will probably result in a marked extension of this use of slag At present the American iron industry is in such a prosperous condition that it is difficult to convince its managers that such economies are desirable, but whenever a dull period sets in all are willing to find some profitable use for this by-product.

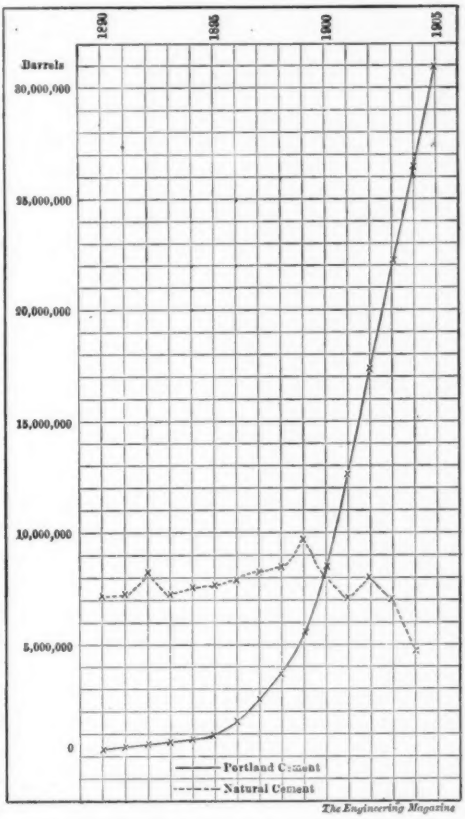
The distribution of the Portland-cement industry of the United States is shown in the following table, which gives detailed statistics for three recent years, and is brought out graphically on the map which appears on the preceding page.

State.	1902. Number of works.	1902. Quantity.	1902. Value.	1903. Number of works.	1903. Quantity.	1903. Value.	1904. Number of works.	1904. Quantity.	1904. Value.
		Barrels.			Barrels.			Barrels.	
Ala.	1	.....	.....	1	.....	.....	1	.....	.....
Ark.	1	.....	.....	1	.....	.....	1	.....	.....
Cal.	2	294,156	$431,910	3	631,151	$1.019,352	3	1,014,558	$1,446,909
Col.	2	82,044	105,016	1	258,773	436,535	1	490,294	638,167
Ga.	0	.....	.....	1	.....	.....	1	.....	.....
Ill.	4	767,781	977,541	4	1,257,500	1,914,500	5	1,326,794	1,449,114
Ind.	3	536,706	628,244	3	1,077,137	1,347,797	4	1,350,714	1,232,071
Kan.	1	830,050	1,017,824	1	1,019,682	1,285,310	2	2,643,939	2,134,612
Mich.	10	1,577,006	2,134,396	13	1,955,183	2,674,780	16	2,247,160	2,365,656
Miss.	1	.....	.....	2	825,257	1,164,834	2	.....	.....
N. J.	2	2,152,158	2,563,355	3	2,693,381	2,944,604	3	2,799,419	2,099,564
N. Y.	8	1,156,807	1,521,553	10	1,602,946	2,031,310	10	1,362,514	1,257,561
Ohio	7	563,113	685,571	8	729,519	998,300	7	910,297	987,899
Pa.	15	8,770,454	10,130,432	16	9,754,313	11,205,892	17	11,496,099	8,969,206
S. D.	1	.....	.....	1	.....	.....	1	.....	.....
Tex.	2	165,500	234,950	1	.....	.....	1	.....	.....
Utah	1	.....	.....	1	.....	.....		.....	.....
Va.	1	334,869	433,286	1	538,131	690,105	1	864,093	774,360
W. Va.		.....	.....	1	.....	.....	1	.....	.....
Total.	62	17,230,644	20,864,078	71	22,342,973	27,713,319	79	26,505,881	23,355,119

In the table above Alabama, Georgia, West Virginia, and Virginia are reported together; the products of Kansas and Missouri are given in combination; and Colorado, Utah, and Texas have their products combined. In each case the combined product is given in connection with the State which was the largest producer.

About three-fifths of the entire American production comes from a small area in southeastern Pennsylvania and western New Jersey, the so-called Lehigh district. As at present developed this district contains over twenty cement plants within an area about twenty-five miles long and four miles wide, and produces in the neighborhood of 20,000,000 barrels of Portland cement annually.

Reference has been earlier made to the fact that the Portland-cement industry started in the United States about a half-century after the manufacture of natural cement was commenced. The recent relations of the two industries are shown in the accompanying diagram.



ANNUAL PRODUCTION OF PORTLAND AND NATURAL CEMENTS, 1890-1905.

It will be seen that while natural cement has shown little advance in production during the fifteen years plotted, Portland cement has shown a surprising increase, and now far outdistances its competitor. In the past few years, however, improvements have been effected at certain natural-cement plants which seem likely to give a new life to that industry.

Portland cement, on the other hand, has increased steadily and rapidly in output and use, and there seems no reason to believe that this increase will be materially retarded for many years. The product is being constantly employed for new uses, the most striking develop-

ments of the past few years being in the line of its employment with steel as reinforced concrete, and in the rapid extension of its use as an achitectural material in the form of concrete blocks.

Certain interesting features of the American cement trade are brought out by the following table of domestic production, imports and exports. It will be seen that while the imports have decreased little in absolute quantity, their relative importance has fallen off rapidly, while a small export trade is now in course of development.

Year.	U. S. Production. Barrels.	Imports. Barrels.	Exports. Barrels.
1890.....	335,500	1,940,186	.....
1893.....	590,652	2,674,149	.....
1895.....	990,324	2,997,395	.....
1897.....	2,677,775	2,090,924	.....
1898.....	3,692,284	1,152,861	.....
1899.....	5,652,266	2,083,056	.....
1900.....	8,482,020	2,321,416	100,400
1901.....	12,711,225	922,426	373,934
1902.....	17,230,644	1,963,023	340,821
1903.....	22,342,973	2,251,969	285,463
1904.....	26,505,881	968,410	774,940

A modern Portland-cement plant, of American type, capable of turning out 2,000 barrels per day, would employ in its quarry and mill some 200 to 250 men. Of these at least four-fifths are unskilled laborers, while unionism has not taken serious hold anywhere among the skilled laborers, so that the industry has been fairly free from labor difficulties. Such a plant would probably represent an investment, including costs of land and plant, and working capital, of some $1,000,000 to $1,500,000. The cement industry is not one in which the manufacture can profitably be carried on in a small way, except in districts remote from competition, and the plant above cited can not be regarded as exceptionally large. It is evident, therefore, that the cement industry is not one for individuals or small companies.

On the other hand, the Portland-cement industry does not lend itself readily to any idea of monopoly. Proper raw materials are too common to permit this, for there is hardly a county in the United States in which cement could not be made, if prices were forced high enough to justify the undertaking. The American industry has so far been marked rather by too free competition than by the reverse, though at intervals the newspapers may inveigh against the enormous profits realized by a purely imaginary Cement Trust. Now, whatever may be said about monopolies and trusts, absolutely unrestricted competition is not desirable, and there are already signs that in some districts the cement plants have realized that a certain community of interest should exist. The development of this idea may be watched with some interest during the next few years.

APPLICATIONS OF PNEUMATIC POWER IN THE MACHINE SHOP.

By R. Emerson.

THERE was a general tendency during the Nineteenth Century toward the centralization of prime-movers and the operation of all classes of machinery by transmitted power. Among the most common systems of distribution are mechanical (shaft; rope, belt or chain); hydraulic, pneumatic, and electric. The mechanical distribution systems are costly to install, and somewhat cumbersome; their practical range is but a few hundred feet.

Hydraulic transmission is objectionable for general use because of the many leaks, and the problem of disposing of the "used" water. Pneumatic transmissions, unless carefully designed, are subject to water-condensation troubles and to invisible leakage. If proper care is exercised to install pipes and joints that do not leak, the practical radius of use (while not usually comparable in length to long-distance electric transmission) is very considerable; and in special cases the system has a number of advantages over electricity. The relative generating, transmitting and operative efficiency, in shops or works installations, or in small plants, is not in favor of electricity; although the costs of piping and wiring, for equal powers, are comparable, the initial costs of generators, *versus* compressors, of electric *versus* air motors, of transformers *versus* reservoirs (not to speak even of switchboards) are greatly to the advantage of the pneumatic equipment. The lack of danger in an air system has been cited,—an important feature in tools working in close quarters on metals; and the greater portability of the air tools now on the market compared with the electric contrivances thus far in general use in the United States and in Germany, is a point of advantage that every shop man (and shop men must use the machines) will vouch for. A further underlying advantage is that electricity is used practically to impart rotary motion alone, whereas air has an endless variety of uses. Thus it is that compressed air has found favor in mining, bridge and shipbuilding, structural steel work, in erecting-shop work; that in a recent large quarry installation it was preferred, though the lines ran two miles from the power plant; that in the early development of Niagara Falls as a power center, it was proposed to use compressed-

WORKING IN CLOSE QUARTERS.

air transmission, and that in British Columbia, at Ainsworth on Kootenai Lake, an automatic air-compressing plant is delivering compressed air to miners within a radius of several miles. Modern railroading, as a further instance, with its high-speed and heavy trains, would have been impossible without the air brake.

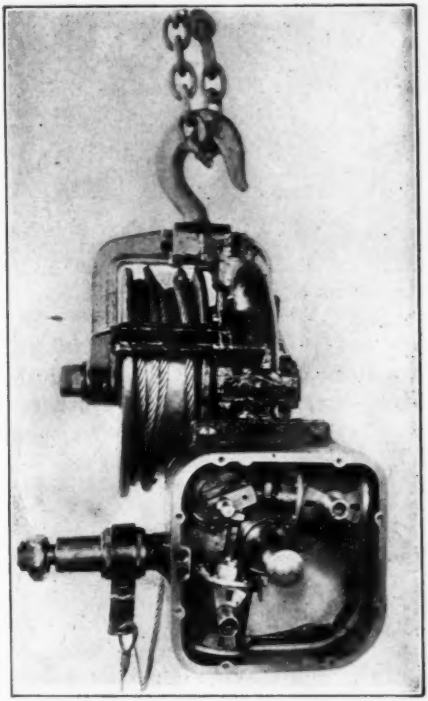
The great variety of uses to which air power can be put has made its development rapid and extensive and its effect on prevailing practices and methods has been so marked as almost to revolutionize every important line of modern engineering. Stone cutters, rock drillers, motors, hammers, yoke riveters, hoists, lifts, presses, carpet cleaners, sand blast, painting machines, conveyors, bolt nippers, jam riveters, flue cutters, holder-ons, air jacks, sand rammers, bell ringers, sand sifters, fire forges, brazing and welding flames — these are a few of the less well-known uses of compressed air.

ONE MAN REAMING IN BOILER STEEL.

Pneumatic and electric motors do not "generate" power; they turn into useful work the energy transformed through

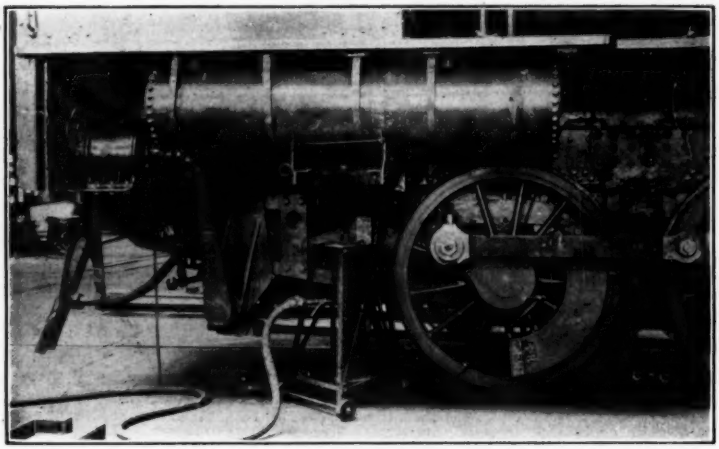
them. Both electric and pneumatic motors are of such recent development that many practices that ought to be obsolete still prevail, especially in railway shops, where competition does not exert the same stimulus as in commercial shops.

The shops of the immediate past had a main shaft driven by a Corliss engine. This shaft drove all the machine tools. There was either a mechanical or a hand crane—or none at all—over the erecting or assembling floor. Present practice drives generators direct by high-speed "automatic" engines; takes the current to large 20- or 30-horse-power motors (relegated to the rafters in the shops), each driving a "group" of machines, through main and countershafts, some heavy machines having individual motor-drive; and also installs an air compressor, reservoir, and piping, with motors and hammers for use on the floor and outside.



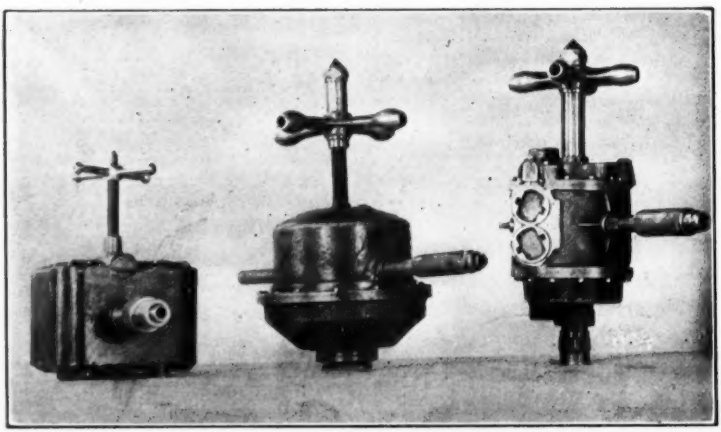
INTERNAL MECHANISM OF AIR HOIST, SHOWING THE SMALL PNEUMATIC ENGINES DRIVING THE WORM OF THE WORM GEAR.

While it is probable that individual and group drive will be retained much as at present, the impending advance in shop betterment with increase of capacity, indicates that many heavy operations will be done by portable tools (whether light electric or air, or the heavier electric-driven machines carried on trucks or transferred by crane) avoiding the effort of moving the mountain to Mohammed. It is this phase of the question that interests us, for it means a transformation not only of work done by hand to work done by power, but also transplanting of work done in the machine shop to work done on the floor, and the sav-



NEW METHOD OF JACKING AIR RESERVOIR WITH AN AIR-OPERATED DRUM-HOIST. IN MARKED CONTRAST TO THE OLD CUMBERSOME BLOCKING-UP.

ings and economies to be effected will be considerably greater than those obtained through individual or group electric machine-drives—greater even than those obtained by high-speed steels. For example: if it takes 14 hours to set up a job and 6 to do it, of which during less than 3 a high-speed tool is actually cutting, a saving of 10 or 12 hours might be realized by moving a portable tool to the part to be repaired or machined.



TYPICAL MOTORS, WITH FEED SCREWS EXTENDED.

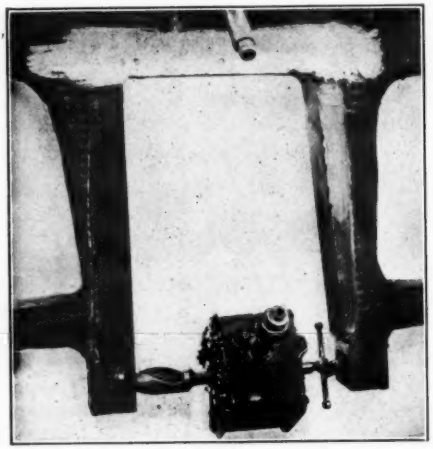
A few years ago (and even in some shops today) all drilling, tapping, chipping, calking, riveting, reaming, flue rolling, grinding of joints, cutting, beading, valve-seat facing, ramming, etc., was done entirely by hand, and there was no such thing as an air-lift to handle work for heavy machines; today all progressive shops are dependent on air for economical production.

A "HAND" JOB DONE BY AIR.
Drilling in a locomotive fire-door.

The Evolution of Motors into Modern Types.—Having a general conspectus of the field of work to which portable power-driven tools are applicable, it is interesting to note the recent development and improvement in design of these tools before passing to the consideration of intrinsic merits of modern types.

The earlier motors were heavy and unwieldy compared to those now in use. One of the first was the product of a boiler-shop foreman in a western railway shop. Later, an improved motor, and an air hammer, were developed. A young mechanic, seeing this hammer in operation and realizing its advantages in chipping cast-

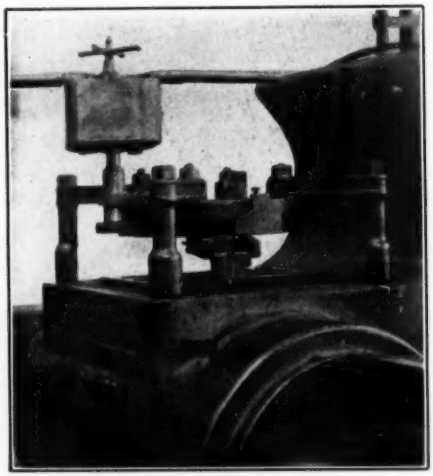
A "HAND" JOB IN NARROW QUARTERS.



DRILLING FOR PEDESTAL BOLT HOLES IN A LOCOMOTIVE FRAME.

ings, introduced himself to the inventor, who in a small shop employing four or five men, was making these tools.

The mechanic, who was an able demonstrator, combined with this quality an unusually pleasing personality, great imaginative fore-sight, organizing ability. and unbounded enthusiasm. He agreed to take, and to sell, the entire product of the little shop. Within twelve months, the shop output had been increased manifold, and a few years later the inventor was enabled to retire with a large fortune. Great credit must be given to these pioneers through whose efforts this innovation was put into practical and economical use. It is no small achievement to change radically time-honored methods of the mechanical trades in the space of less than a generation, especially when it is realized that the machines in question were far from being perfect when they were first taken hold of by these men.



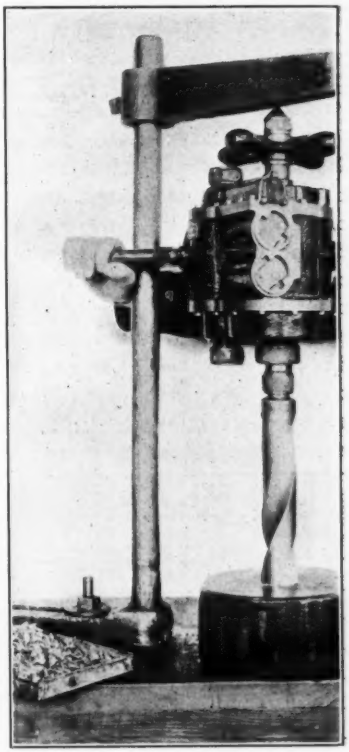
VALVE-SEAT-FACING ARRANGEMENT.

This brief sketch illustrates the newness of the air-motor as a practical machine, and its rapid extension to many lines of work.

The early motors were unwieldy and inefficient to such an extent that there was great difficulty in persuading men to use them. "Old men," dogs, braces,

clamps, had to be rigged up before the machine could be used; but even with a helper (and the weight and vibration of the motor necessitated two men) the men were loth to employ air tools, because of the difficulty in handling. The average man on day work seeks not how quickly, but how easily, to do a job.

Productive Efficiency in the Shop.—An air tool, however, like all other machinery, is intended as a help to the men and work, and not as a hindrance, so rival manufacturers have continually had before them the stimulus to make a machine that would not only do the work—do "hand" work in very close quarters—but that would also be easy and convenient to use—that would save, not increase, the man's effort. Realizing the necessity of securing the hearty and willing co-operation of the workers, shop officials have become more critical, have instituted tests of efficiency and power, of durability, and of economy of maintenance in proportion to weight, and these tests have thus reacted on the business of the manufacturers, forcing them by competition to improve their air tools.



MODERN HEAVY DRILLING, WITH AN "OLD MAN."

As an instance of the interest and influence of users of air tools, a railroad official asked various manufacturers to submit their most efficient and useful machines for test. These and some six of the older type machines were thoroughly tested, at various speeds, under various loads, and with different air pressures. Gauge, meter, scale, and revolution readings were taken at half-minute intervals, and endurance tests of half a day were also carried out. From these tests, and from records kept of service of motors and of itemized repairs made to each machine, extending over a period

of two years, the data in the accompanying diagrams are taken. Consequent upon the tests and their calculated results, orders were placed in several sizes for a number of each of the best machines.

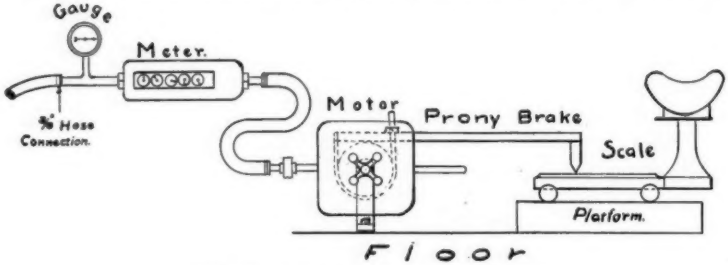


DIAGRAM OF METHOD OF TESTING MOTORS.

These machines, allotted to certain men and gangs in the shops, came at once into general favor, and owing to a rigorous system of inspection and repair (blank forms of the records of which are herewith shown), their efficiency was far higher than had been the case with the older machines, while the repair cost per hours worked fell below that of previous experience.

Certain of the machines were not assigned to definite gangs, but were for general use. The men who had need of a machine demanded one of the new ones. One make of machine was in particular favor because of its lightness. In fact, there were cases where men had to be disciplined for failing to turn in motors on Saturday night for in-

BLANK R. R. COMPANY
Individual Motor Work Report

Date	Make	No.	Work:
Feb 3	D	34	Broken toggle
"	a	8	Broken piston, and back rod
"	D	32	Broken toggle
Feb 4	B	20	Cracked Cylinder
"	B	23	Cracked Cylinder
"	E	51	Broken casing
"	D	31	New toggle and worn out crank
Feb 5	D	34	Pins replaced in toggle
"	X	16	Valve repaired
Feb 6	B	26	Cylinder broken; new packing rings

FORM FOR RECORDING AIR-MOTOR REPAIRS.

BLANK R. R. COMPANY

Date	Make "A" No.	Make "B"	Make "C"	Make "D"	Make "E"	Misc. Makes	
Feb 3	8 12 3			32,34 1 5			
Feb 4		21,23,4 8		31 1 ½	51 1½		
Feb 5				34 1 2		X 16	1
Feb 6		26 5 6					

FORM FOR RECORDING HOURS OF LABOR, INSPECTION, CLEANING, AND REPAIR SPENT UPON EACH MOTOR.

spection, because they feared that they might miss getting the same machine Monday morning. Men who would not use a motor previously now began proposing its application to all kinds of jobs, and results in most cases justified complying with these suggestions.

Hitherto undesirable jobs of reaming, and drilling in contracted

BLANK R. R. COMPANY

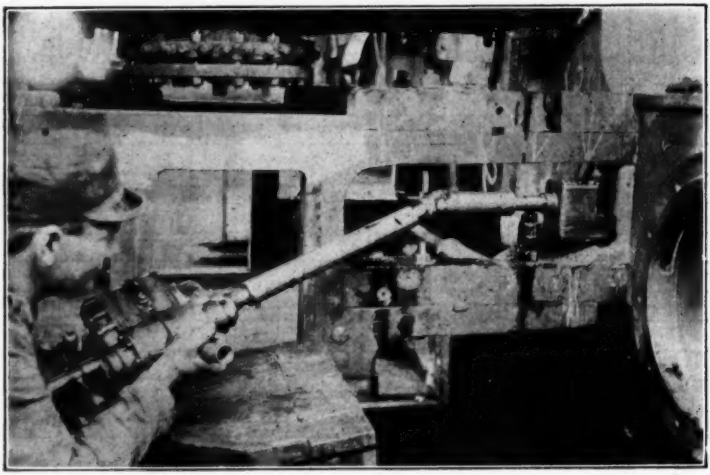
Date	Make "A" No. G'g Hrs	"B"	"C"	"D"	"E"	Misc.	
Feb 3	1 C 10	20 [illegible] 4	81 M 10	30 [illegible] 10	51 [illegible] 8	X 16 [illegible] 5	
"	2 [illegible] 8	21 [illegible] 10	82 M 9	31 [illegible] 5	52 L 7	Q 18 [illegible] 3	"
"	4 H 9	22 [illegible] 8	83 E 10	32 B 6		Z 71 [illegible] 8	
"	5 K 0	23 H 2	84 - 0	33 H 5		Z 72 0	
"	C [illegible] 2	24 [illegible] 7		34 K 10			
"	7 B 7	25 - 0		35 - 0			
"	8 M 1	26 C 0					
"		27 - 0					

FORM FOR RECORDING HOURS OF SERVICE OF EACH MOTOR.

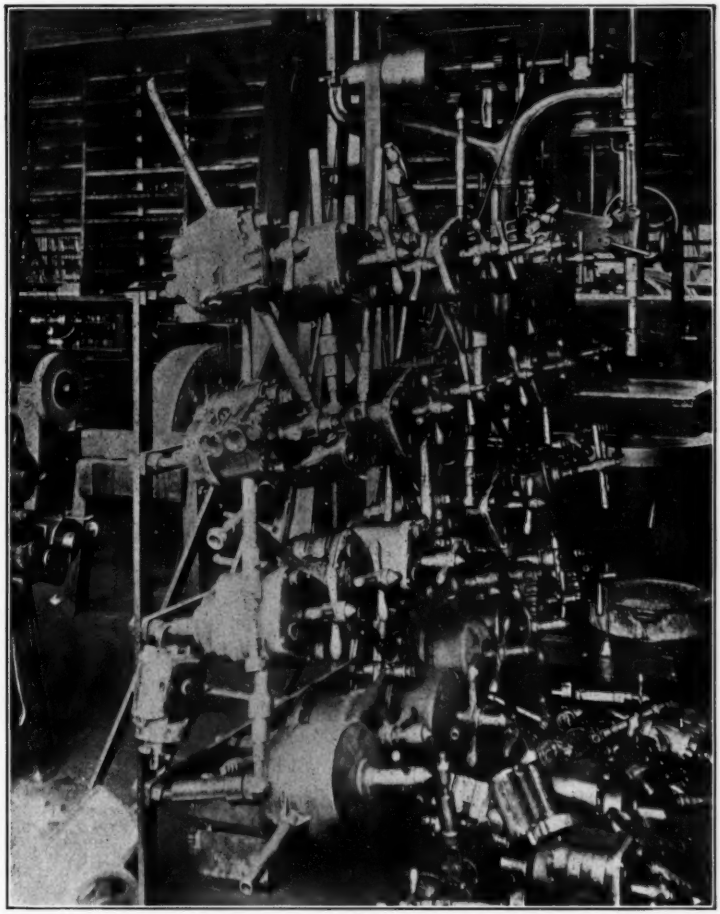
"G'g" means gang (or man) using each machine. All the forms shown are 8 by 5 inches, the horizontal lines being spaced 1/3 inch apart; ruled in light blue except the dotted lines, which are red; printed in brown.

GETTING MOTORS FROM THE TOOL ROOM.

spaces, were made so much easier that they were no longer shunned. The one item of reaming holes alone was cut to less than one quarter the former labor cost, when a heavier type of machine was



AN "UNDESIRABLE" JOB, MADE EASY BY USE OF ANGLE DEVICES IN CONNECTION WITH AN AIR MOTOR.



CONVENIENT RACK FOR STORING AIR MOTORS.
Designed by a tool-room machinist.

used. This was due to the fact that the mechanic did not need a helper and could work more quickly and to better advantage.

It will be noted that a number of repair items in the sample record illustrated are quite heavy; and it should be explained that these machines were the total of those "out-of-business" among over one-hundred in use in the shops, and that as there was a system of pay in effect rewarding men according to their individual effort, it was con-

sidered greater economy to wear out the machine by continual and heavy service, than to save the machine at the expense of shop output costs.

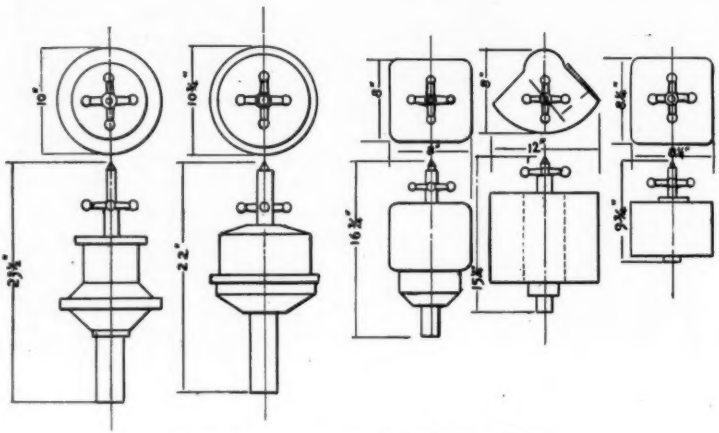


DIAGRAM OF COMPARATIVE SIZES OF MOTORS.

Comparative Motor Performance.—There is subjoined an outline drawing showing the general dimensions and sizes of the five principal motors put on the market in the past ten years. These motors have all received extensive use and are the best representatives of the most successful, mechanically and commercially, of the motors of the period mentioned. They are arranged, with one exception, in the order of their appearance on the market and the progress in lightness and compactness is very evident.

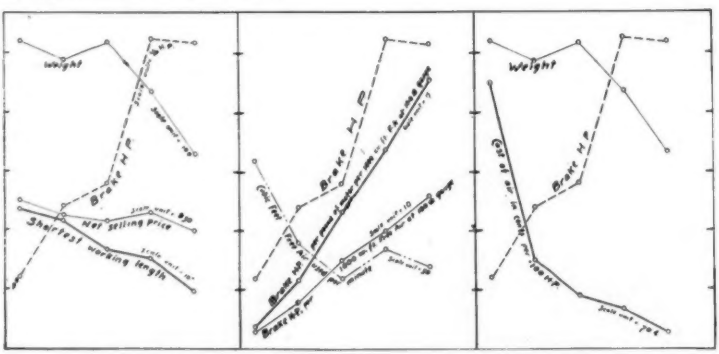
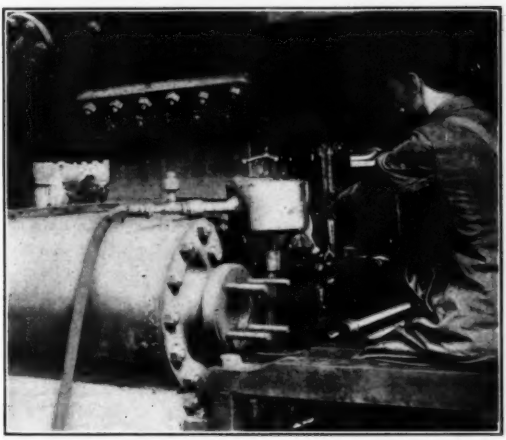
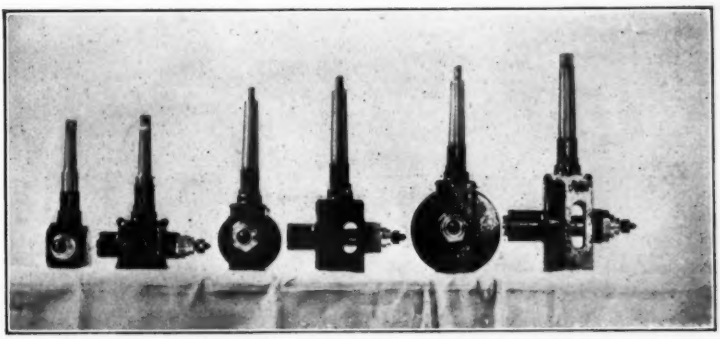


DIAGRAM OF DATA BROUGHT OUT BY TESTS OF AIR MOTORS.
Mean results of three-weeks test upon eight machines, using the method shown in the diagram above.

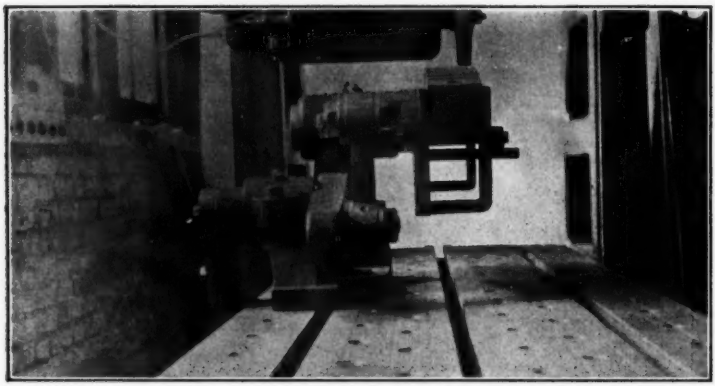


A FORMERLY "UNDESIRABLE" JOB OF REAMING, NOW DONE COMFORTABLY BY AIR TOOLS.

Some of the data obtained in the motor test are worthy of attention. The cost of compressed air was determined by a thorough one-week's test of the power plant. In the diagrams the small circles represent the five motors in the order in which they appear in the outline drawing. It will be seen that the net purchase price (in quantity) of these tools has slightly decreased, yet the design has been improved. The efficiency of the motor has increased in every way, also, in a surprising degree—the losses in the older types being due to large leverages and consequent working loose and wearing of parts, and to poor piston fits. It should here be stated, however, that in this series of tests the machines selected were all in good condition, the new ones having been "warmed up" by a few weeks of "active service" and the older machines having been previously put in thorough repair and adjustment, so that each machine might give the best performance of which it was capable.



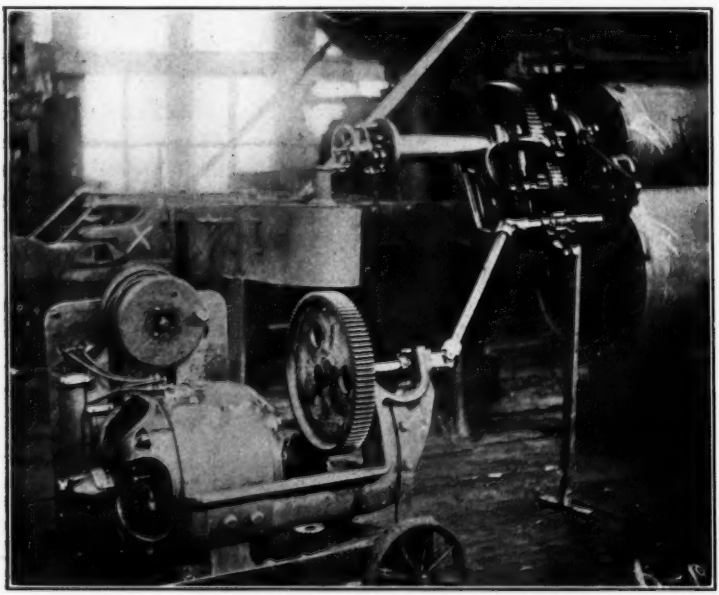
A GROUP OF ANGLE DEVICES FOR USE WITH AIR MOTORS.



PORTABLE ELECTRIC MOTOR CLAMPED TO A PLANER FRAME, ENGAGED IN GRINDING LINKS FOR LOCOMOTIVE.

Referring to the last of the three diagrams, the line representing relative costs of operation per unit of work is most striking.

The earlier casings and parts were heavy and large, to withstand as yet undetermined strains. Little attention was paid to the selection



A TRANSPORTABLE ELECTRIC MOTOR.

or testing of the materials used in the motor. The tool was driven at a point far away from the crank, and as no provision was made for balancing, the vibration was excessive. The oiling also was unsatisfactory. In the old "wing"-type motors it was difficult to keep the mechanism properly oiled, as the air driving the motor carried out the oil in the exhaust. In the later types, the cranks run in oil, and the air comes in contact with the piston only.

Simplicity of design, compactness, fewness of parts, are the elements that characterize the later types of motor. The strongest motor is not the heaviest; the most powerful is not the largest.

In examining into the reasons for the increased economy and compactness of the later types in proportion to power developed, it may be stated that a higher number of revolutions of tool-socket per minute has been one of the factors. In one of the later types, a two-speed gear provides for both slow and fast operations and this has been found of great use.

An important point is that in the earlier types, the repair and maintenance costs, as well as the operative costs, were excessively high, and that owing to this condition, the time lost by the machine to productive service was very great. Even under these disadvantages the early machines were able to compete economically with hand labor; and now it is a very favorable sign that the tendency is toward:

Decrease of weight, decrease of first cost, decrease of maintenance cost, decrease of operative cost, increase of efficiency and economy, increase in applicability to various classes of work, increase of time in service.

While it has been shown that the air motor has well earned an important place in modern industry, and is likely to extend its usefulness, it cannot of course be claimed that the field of power-driven portable tools will be held exclusively by pneumatic tools. There are certain classes and conditions of work for which they are peculiarly adapted, and in general practice, for reasons already mentioned, they will hold their own for long to come over electric and other rivals.

Portable Electric Motor.—In the past the electric motor has been handicapped in its introduction as a portable tool because of its great weight and comparatively high first cost, proportionate to horse-power developed. For this reason the air motor has held a virtual monopoly of this class of work, even in this "Age of Electricity." Owing to great improvements in design in the past two years, such as air-cooling of coils, etc., the electric portable motor is coming in for serious attention for practical shop-production improvement. An

even further reduction of some 10 per cent in weight is possible by the use of aluminum in armature and field coils.

The illustrations show one type of portable electric motor, attached to a planer, grinding links which are given the proper motion by a jig on the bed of the planer. The common cord and Edison plug are used to make connections, with great convenience. While these motors are quite light, there is prospect of their being made still more so in future.

Although these motors are too new upon the market to venture any data as to their permanent efficiency compared with air tools of the same capacity, it may be said that they will find a very ready use in shops not at present equipped with an air-compressor, where electric energy is available. Automobile plants, buying their current, will especially find their use economical.

Considerations Governing Purchaser.—Not always having the advantage of special knowledge, or of experience, and lacking time and facilities for testing out before purchase, works managers and superintendents may be in doubt as to the paying value or comparative worth of all the machines and devices drawn to their attention by enterprising supply companies. To such men on the look-out for improved methods, and indeed to all intending purchasers of air-tool equipment, three main considerations are presented:

The tool should be of general adaptability. This is most important, and should largely govern the selection.

It should be maintained and operated at low cost.

Its first cost should not be prohibitive.

As is usually the case, the simplest and most compact motor, of light weight, of few parts, is at once most adaptable, easiest to maintain, and cheapest to make. Fewness of parts calls for less material, and less labor per piece. Assembly costs are less, as cheaper labor may be employed. What is here said of manufacturing costs applies equally to repair expense; with fewer parts there is less liability for wear, for lost motion, for breakage; there are fewer "extra" pieces to carry in stock, and there is increased time service.

No one cares to invest in a high-priced tool whose use is limited to a small class of work. I have seen contract shops loaded down with useless and expensive machinery, much of it standing idle the greater part of the time. In many modern railroad shops, the machine equipment is ill chosen, this being the main cause of the high repair costs prevalent in the last few years. If, however, one can be assured that the tool to be purchased, whether a heavy machine tool or a portable one, will be in constant service, the investment is well worth while.

EDITORIAL COMMENT

THE "thick weather" which for some time has been settling about the Panama Canal has apparently reached such conditions that only a lively squall, with much thunder and lightning, can effectually clear the atmosphere. That squall is now on in the Senate; and it may after all be welcomed, because when it has spent itself the situation will be revealed so clearly that a safe course can be made for the future.

The truth of the case doubtless lies between the impossibly perfect picture drawn by the Administration and the yet more impossibly hideous one painted by sensational attackers in both the daily newspapers and the periodical press. And it must be borne in mind that if critics of the work have based charges more or less personal upon information which was wrong, or wholly insufficient, the precedent was set by those high in authority in the conduct of the Canal construction. The correspondent who makes violent accusations against Mr. Taft or Mr. Shonts, on mere hearsay, is more excusable than Mr. Taft and Mr. Shonts are, for example, when they insinuate publicly that Mr. Wallace dumped the Culebra spoil where it would have to be moved again in the further work, and then add hastily that this insinuation is based upon rumor which they have not verified. The high official position which gave them every facility —indeed, imposed upon them the duty —to know the facts, doubled their grave responsibility in attacking an honorable professional reputation.

The course of events since our editorial reference last month, in which we pointed out the eminent desirability of letting the whole work by contract, has proved that position as no mere argument could ever have done. We are glad, indeed, to see that within the past few days Mr. Shonts and Mr. Stevens have expressed similar opinions. The whole country is in a turmoil over a job which, at the utmost, represents not more than half the volume of the engineering work now under way in and about the city of New York—proceeding, under the contract system, without confusion and almost without public notice. The greater part of the machinery of the Federal Government is diverted from its proper functions to the carrying on of the Canal investigation, and the whole executive management of the Canal is distracted from constructive effort to the business of being investigated. And so long as we persist in our present policy these conditions will be prolonged and repeated.

The methods and the machinery of Government bureaus and political offices may serve excellently for the transaction of official routine; they are hopelessly inefficient when turned upon constructive enterprise—especially upon any large engineering undertaking. Witness the public buildings all over the United States, and the glaring examples under the river and harbor bills. The nature and necessities of the two spheres are wholly dissimilar; it is no disparagement to either that it cannot properly perform the functions of the other. The only folly is to persist upon trying. The engineering staff of (say) the Pennsylvania Railroad, even by and with the assistance of two of the great engineering societies, would probably find themselves ill adapted to conduct the affairs of the

Department of State, and would frankly admit their inefficiency on the job; but they would not be farther from their ideals than the War Department is in trying to manage the building of the Panama Canal. Indeed, of the two the engineers might come best out of the situation.

We do not hold for a moment that this implies any lack of personal capacity or of the most earnest purpose on the part of the President or the Secretary. They are doubtless doing all that any men could to carry out the difficult commission placed upon them by the country. But what of the very possible change of personnel in the highest offices which may occur before the Canal is finished? What if the energy and knowledge of President Roosevelt and Mr. Taft should be displaced by a vacillation, an unfamiliarity with or even an unfriendliness to the work, in the persons of their successors? Further, the Canal will always appear to enemies of the Administration to be a most vulnerable point —a sort of football of politics; and with each new Congress there will be new attempts—possibly with the very best motive behind them—to reopen the most fundamental questions in the whole concept.

A great physical problem dealing with the facts and forces of Nature cannot be practically solved under such conditions. In the interest of the President and his Cabinet, as well as in the National interest, the charge given the Administration should be so modified (if, indeed, modification of its form is necessary) that it demands from them nothing except that which is within the sphere of their proper office.

In other words, to cite recent concrete examples, the work should be done as in the case of the New York Subway or the Chicago Drainage Canal —upon plans determined by a competent commission, under the constant and effective supervision of their engineers, but by an organization, a mechanical equipment, and working methods supplied by the contractors. This is, indeed, the method by which the greatest engineering works of the world, and all over the world, have been completed—with the maximum of efficiency, the minimum of cost, and the absence of scandal.

It implies no surrender of control of any essential feature either of plan or policy. Any and every provision which National ideals or public expediency may suggest can be embodied in the specifications. The public eye, as well as the official eye, can be and would be over the work night and day. And it would be easier even than now to secure, for the oversight and control, men who are above reproach, personal or professional.

We hope that the present inquiry may carry the light into the farthest corners of the Isthmus and of the departments at Washington—that every one who has evidence to give or a grievance to allege may appear and be heard to his heart's content. This is the time for it. But as sincere and consistent advocates of the best canal, for the least cost, and in the shortest time possible, we most earnestly hope that the era of talk may then give place to the era of work. And, in our conviction, this involves two steps:—

First, prompt decision upon the plans and specifications.

Second, commitment of the construction, upon well-established and elsewhere universally successful lines, and after open competition, to competent, responsible, and amply bonded contractors or contracting organizations.

The policy which built successfully the great railroads of the United States and the vast majority of all the important engineering projects conceived and carried out by our shrewdest financiers and ablest business managers, without friction or disturbance of municipal, State, or National affairs, is the only sane and safe policy for the building of the Panama Canal.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE RESISTANCE OF MATERIALS TO SHEAR.

EXPERIMENTAL TESTS TO DETERMINE THE ACTUAL BEHAVIOUR OF MATERIALS OF CONSTRUCTION UNDER SHEARING STRESSES.

E. G. Izod—Institution of Mechanical Engineers.

AMONG the various conditions of stress to which materials of engineering are subjected in construction and operation that of shearing action has been given a smaller share of attention than its importance warrants. By far the greater number of tests of materials are made by subjecting the specimen to tension, while compression tests, torsion tests, drop tests, and other forms of trial have been largely employed. In many of the text books the resistance of a material to shear is based upon the resistance to tension, an arbitrary relation being given without due attention to the obvious fact that this relation must differ for materials of different kinds. The importance of the study of shearing action is manifest when it is considered that it exists in nearly every case in combination with other stresses, and in some instances it may become the element of controlling importance as regards the safety of the structure under consideration. Thus, in the case of a deflected beam, the upper portion may be under tension while the lower part is in compression, but manifestly the neutral plane, where tension ceases and compression begins, is under shear, the forces above and below acting in opposite directions. In like manner shear forms an important element among the stresses existing in cases of torsion, and it is well known that the recent re-investigation of the distribution of shearing stresses in masonry dams has attracted much attention and created some little apprehension in connection with such structures. In a paper recently presented before the Institution of Mechanical Engineers by Mr. E. G. Izod there is given the results of some actual tests made to determine the behaviour of materials under pure shear, and the results may be received as a welcome addition to a department of engineering in which the stock of information is none too complete.

The experiments of Mr. Izod were made in the engineering laboratory of University College, using a 100,000-pound Greenwood & Batley testing machine with special clamps arranged so as to eliminate, as far as practicable, any bending of the test piece, and to insure the production of a pure shearing action. The tests were made upon pieces of rectangular section, and tensile tests were also made upon corresponding pieces of the same materials, the intention being to discover what relation, if any, existed between the resistances to shearing and to tensile stress. The tests included such materials as cast iron, wrought iron, steel, and a variety of bronzes and brasses, the steels including mild steel plate and Swedish crucible steels with carbon content from 0.12 to 0.77 per cent., the results being tabulated and plotted in curves.

For the details of the tests the reader must be referred to the original paper, but some of the interesting points brought out in the paper and in the discussion may be noted here. Apparently no positive relation exists between the shearing resistance and the tensile strength of a material.

"All the results obtained in the experiments seem to point to the fact that there

is no common law connecting the ultimate shearing stress with the ultimate tensile stress, the ratio varying greatly with different materials. The test figures from the crystalline materials, such as cast iron or those with very little or no elongation, seem to indicate that the ultimate shear stress exceeds the ultimate tensile stress by as much as 20 or 25 per cent., while from the fibrous materials, or, more properly speaking, those with a fairly high measure of ductility, the ultimate shear stress may be anything from 0 to 50 per cent. less than the ultimate tensile stress."

Thus, for wrought iron, the shearing strength appears to be about 75 per cent. of the tensile resistance, while for cast iron the resistance to shear runs from 10 to 52 per cent. above the tensile strength. The low-carbon steels show about the same ratio as wrought iron, while a crucible steel of 0.71 carbon has a shearing strength of 65 per cent. of the tensile.

In comparing the ratio of shearing to tensile resistance with the elongation, a certain relation appears, there being a certain uniformity in the results. Thus, when the ratio of the shearing to the tensile resistance is close to 60 per cent., the elongation shows very little variation from 10 per cent. Below and above the 60 per cent. ratio the elongation increases, that at the 50 per cent. ratio being almost equal to that at 70 per cent., while from the 70 per cent. ratio upwards the variation is inclined to be regular, the elongation decreasing as the ratio becomes higher, until with a very small, or practically no elongation the ratio might be expected to become 120 per cent. or 130 per cent.—that is, that the ultimate shear would exceed the ultimate tensile stress by 20 or 30 per cent.

In the course of the discussion on Mr. Izod's paper some interesting points were brought out. Thus, Professor Lilly called attention to the fact that tests for ultimate strength were destructive tests, so that the load is not uniformly applied over the entire section, and that different results are obtained with different depths of test piece. He also spoke of the fact that the shearing resistance bears a relation both to the tensile strength and the compressive strength of a material. In this respect it may be of interest to note the investigations of Professor Mörsch, in Switzerland, reviewed in the issue of this Magazine for March, 1905. Although the investigations of Professor Mörsch related more especially to concrete, they included the general question of the relation of shearing stresses to tension and compression, and showed that in general, the resistance to shearing is found to be a mean proportional between the tensile and the compressive strength, so that the resistance to shearing may be taken as the square root of the product of the tensile and compressive resistances. Since Mr. Izod does not give the compressive resistances of his test pieces it is not possible to apply this rule to his experiments, but it can well be seen that for materials with a proportionately high resistance to compression, such as cast iron, this would give a shearing resistance materially higher than the tensile strength, while for a material in which the compressive resistance is lower than the resistance to tension the ratio would be lowered. An examination of the appearance of the ruptured sections of specimens divided by shearing will show that both the tensile and the compressive resistances of the material have been overcome, and hence it is but reasonable to expect that the shearing resistance should be a function of them both.

There is little doubt that resistance to shearing plays an important part in nearly every form of resistance to stress, and this is indicated by the fact that when rupture occurs it nearly always takes place in some other direction than that normal to the applied stress. Thus, in the case of yielding to tension, the test piece very rarely yields by breaking straight across, the break being in a diagonal direction, or with a conical fracture. When tubes are ruptured by internal pressure the break is a diagonal one, unless, by reason of a weld, seam, or other change in homogeneity the line of the break is otherwise localized. In every case there are undoubtedly a number of causes and effects operating together, and it is a distinct error to assume that one particular cause can be selected as producing an especial effect.

Such experiments as those of Mr. Izod are to be welcomed, but it is greatly to be desired that any such piece of work should be undertaken with an entirely open mind,

not with the preconceived intention of finding out the relation, as in this case, between the tensile and the shearing resistance, but in a spirit of unbiased investigation of all the associated phenomena, so that the true relations of all the elements involved may be determined. If, in connection with these valuable tests, there had been associated a simultaneous set of tests of the tensile, compressive, torsional, and bending resistances, together with the chemical and physical properties of the various specimens, and the resulting mass of data had been critically examined to discover the nature of their relations, there is little doubt that a different set of conclusions would have been reached. Independent investigations are not to be discouraged in any case, but it requires only an examination of such painstaking work as that performed by Mr. Izod to render it evident that it is only by a concerted attack upon the action of molecular forces that the true nature of their action can be discovered.

MODERN FOUNDRY PRACTICE.

TENDENCIES TOWARD COMMERCIAL AND TECHNICAL REFINEMENTS IN THE CONDUCT OF FOUNDRY OPERATIONS IN THE UNITED STATES.

Dr. Richard Moldenke—New England Foundrymen's Association.

IT has often been remarked that the foundry is the one department of the machine works which has lagged behind in the march of improvement, and a few years ago such a statement might have been made with a fair approach to accuracy. The rapid progress in all departments of industry of late has extended to the foundry, however, and to-day, in first-class establishments the latest developments of chemistry, metallurgy, and mechanism are applied to improve the quality and reduce the cost of the product. In a paper recently presented before the New England Foundrymen's Association by Dr. Richard Moldenke, this tendency toward the introduction of refinements in foundry practice is discussed, with especial reference to foundry work in the United States, and we make some abstract and review of this discussion of an important department of engineering work.

"Perhaps the very first thing which strikes the European foundryman who is visiting American plants is the great stress laid upon system and organization in our strictly modern establishments. The European founder, with his more varied work of smaller aggregate tonnage, casts his pieces one by one and finishes each with the assembling following directly. We, with an eye to the finer economies, prefer to put through an order of anywhere from a dozen to thousands of pieces of a kind, finishing them up for sock and stealing the parts required for sales and promises. As the stock in the warehouse gets below a certain minimum another shop order goes in to fill up the gap. As a consequence the work is always produced at the cheapest rates possible. I have personally known single orders of 100,000 castings of some 30 pounds each given with simply a blue print of the casting attached to the document. Many times the quantity has been 30,000 to 60,000, which meant that economical work could be done here if anywhere. Actually the figures at which these castings were carried out would be astonishing.

"Apart from the use of moulding machines to turn out these classes of castings cheaply there is a noticeable tendency to economize shop room, and hence moulds are piled as high as they can be conveniently poured. It may be objected that this method oftentimes produces more sprues per pound of casting than the old way and that if trouble comes a stack of moulds will be ruined instead of only a single one. Yet this system has been found to pay wherever tried and the getting of more tonnage for a given floor space is bound to spread. The idea, however, should be followed out to its logical end wherever work is made in sufficient quantity. This would seem to be the stacking up of the moulds in fairly deep foundry pits, the iron being brought in large ladles by traveling crane and poured from the bottom of the ladle. Suitable variations in the method can naturally be devised for given cases, but the idea remains the same —to get the greatest tonnage for a given

floor space in order to save investment and cost of output.

So far as the question of the preparation of foundry sand is concerned, Dr. Moldenke affirms that European shops are far ahead of those in America. It is by no means difficult to determine the locality in which an American casting has been made, by reason of the different grades of moulding sand employed in different districts, the local sand being generally employed in the United States, whereas, in Europe, selected sands are ground to a given standard, and passed through mixers, giving a uniform material best adapted for the work to be done. The art of tempering sand is counted among the important qualifications of a skilled foundryman, but it is really an operation best performed by the aid of proper mechanical appliances. As a matter of fact, the introduction of mechanical appliances in the foundry is increasing in various departments, including mechanical charging for cupolas and furnaces, conveyors for moulds and for sand, cranes for the foundry and for the yard, and a variety of portable pneumatic tools and appliances. It is nearly always found profitable to replace manual labor by machinery and reserve human effort for operations requiring the possession of brains and the exercise of judgment. The foundry which is provided with the best modern equipment represents a larger investment, but it is better prepared to meet competition and escape labor difficulties.

"There is a growing demand for foundry standards. Thus flasks, pattern work and the moulding methods depending upon the close co-operation of the pattern shop with the moulding floor are coming in for considerable attention. The makers of moulding machines will be greately benefitted by this desired standardization of flasks, for the time has now gone by when a manufacturer would go out of his way to get the most impossible screw thread in order that the repairs subsequently necessary would have to come to him. We shall undoubtedly see the day when all the designs of the drafting office of an industrial establishment will go for revision to its foundry superintendent in order to standardize the non-essential elements therein and create less labor in producing the castings.

"In going through many a foundry where very large loam moulds are made for stock work one cannot help regretting the tearing down of much of the mould which might be left standing if the subject of permanent moulds had been studied more carefully by the foundry foreman. The effort to-day is to economize in every way possible and very often here is a chance to begin.

"We owe much to our high class custom pattern shops for the progress they have forced upon the pattern end of our industry. It is not so long ago that metal patterns were unheard of in many foundries. It seemed like a waste of good money to put more time and effort on a pattern than was required by the ordinary article we all have piled on our pattern shelves. However, many a shop to-day can boast of a set of metal cutting machines which remind one of a first-class tool room. This tendency is, however, closely interwoven with the specialization of the foundry, and where a first-class man is in charge the pattern storage soon becomes less of a graveyard for obsolete material."

An interesting feature in connection with the development of the foundry business appears in the improved character of the buildings of recent construction. This is partly due to the increasing cost of wooden buildings, and also to the desire to avoid the delays and losses due to fire. The loss of patterns in many cases is much less than the loss due to delays in replacing them, and it is evident that good fire protection is better than any practicable insurance.

"Turning now to the melting and the closely allied laboratory we see that the most strongly marked feature is the production of higher grade castings by the addition of steel scrap—or, in other words, the reduction of the total carbon in cast iron, making the crystalline structure more closely adherent and hence the whole casting stronger. Here the skill of the melter is joined with that of the chemist so that value is received from the higher priced stock charged into the cupola. The cupola process is being studied more carefully and experts in that line can produce results close to those of the air furnace or open hearth. Considering that this is accomplished with fuel and metal in contact and by a notoriously unsatisfactory melting

method, which the cupola process undoubtedly is from the standpoint of the treatment the metal gets in it, the foundry industry is to be congratulated upon its ability to retain a strong hold on the making of castings in the face of the hard knocks it is getting from the steel casting establishments. This movement toward better grades of metal is but in its infancy. The cupola, which is a cheap melter, will undoubtedly be improved with the view of getting better results from the steel scrap additions. The metal will be safeguarded more from burning and the additions of the scrap will be systematized more, so that a given quantity will produce given results more regularly than is now the case.

"The tendency above mentioned has somewhat retarded the introduction of air furnaces in general foundry practice. However, taking into consideration the demand for better irons, better coke, better melting methods, the specialist founder will soon tire of buying high class material and spoiling it or taking big chances in that direction. He will naturally revert to the air furnace as better able to give high class results from high class material and the consumer will be glad to pay the difference."

Referring to recent applications of metallurgical improvements in the foundry, Dr. Moldenke speaks of the use of ferro-alloys for correcting various troubles. Ferro-manganese and ferro-aluminum are both extensively used to remedy the defects caused by poor pig and poor coke, but these are only imperfect remedies. Dr. Moldenke believes that the real foundry alloy is yet to be discovered, and hopes that its advent will not be long delayed.

The possibilities of the electric furnace are also indicated and by using cheap fuel gas in gas engines for the economical production of the electric current it appears to be practicable for makers of small castings to use the electric furnace to melt ready prepared stock for steel or bronze castings to advantage. By the employment of preliminary heating processes the use of the expensive electric current may be reserved for the final melting operation, and along such lines there appears to be opportunity for some very practical developments.

SUPERHEATERS FOR STEAM TURBINES.

EXPERIMENTAL TESTS UPON THE ECONOMY EFFECTED BY THE USE OF REHEATERS AND REGENERATORS WITH STEAM TURBINES.

J. Nadrowski and O. Dahlke—Verein Deutscher Ingenieure.

IN the course of the various attempts which have been made to increase the thermal efficiency of the steam turbine, those involving the use of superheated steam have attracted much attention, the experiments of Professor Lewicki, in the laboratory of the technical high school at Dresden being especially noted.

There has recently been conducted at the Dresden high school a series of additional experiments upon the steam turbine, these being made by Messrs. Nadrowski and Dahlke, and involving the use of superheating of the steam before it entered the turbine, as well as the abstraction of all the available heat from the exhaust on its way to the condenser. The experiments also included tests upon compounding, and in these trials arrangements were made for reheating the steam in its passage from the high-pressure to the low-pressure turbine. In view of the general care with which these experiments were conducted and the broad interest at present existing in all that relates to the steam turbine, some abstract of this work is given, with data and results of the trials.

The testing plant at the Dresden laboratory includes a horizontal boiler, with large furnace-flue, the shell of the boiler being 2.30 metres in diameter, and the furnace-flue 1.30 metres inside diameter, with grate 1.20 metres long, and a combustion chamber of about equal length behind the bridge wall, beyond which a retarding wall serves to check the velocity of the gases and guide them through the remainder of the flue, this portion being about 4.50 metres long and 1.25 metres in internal diameter, and arranged to contain the superheating and reheating tubes. The gases, after passing through the internal flue, return beneath

the shell of the boiler on their way to the chimney. As in a number of recent internal-flue boilers, the furnace-flue is not placed on the centre line of the shell, but to one side, this arrangement facilitating the circulation of the water, and in the case of the boiler at the Dresden laboratory there are a number of small tubes run through the water space alongside of the main flue, these tubes being so connected that the exhaust steam from the turbine can be passed through them. There is also a horizontal closed feed-water heater placed by the side of the boiler, this heater consisting of a shell for the water, with a number of straight tubes passing through it for the exhaust steam.

The superheaters are arranged in the form of tubular spirals, placed in the main boiler flue, and hence surrounded by the hot gases passing from the combustion chamber. There is one main central spiral, intended to be used for superheating the live steam before it passes to the turbines, while around this are arranged seven smaller spirals, through which the exhaust from the high-pressure turbine can be passed for reheating the steam before it enters the low-pressure turbine. Both superheaters can be connected in parallel, when extremely high primary superheating is desired.

The turbines themselves are of the De Laval type, one being of 50 and one of 100 horse power, arranged to be coupled together and directly connected to a double Siemens & Halske dynamo, so that the power can be absorbed and measured electrically. The whole arrangement is excellently adapted for experimental research, and from the care with which the installation has been planned the results should be reliable.

In the conduct of the tests the steam consumption was determined by weighing of the feed water, the power required for the feed pump being determined separately, and deducted from the result. The only element which was not properly proportioned to the service was that of the condensation, since the air and circulating pumps formed a part of an independent condensing plant designed for a much larger quantity of steam, and hence was not operated at the best efficiency, a matter which should be taken into account in considering the results. Moderate temperatures were taken with mercury thermometers, while temperatures above 100° C. were measured by means of a thermo-couple, all instruments having been standardized at the Reichsanstalt.

At the commencement of the trials the turbines were operated at very high temperatures, in order to demonstrate what had already been maintained by Professor Lewicki, that there is no difficulty in running turbines of the De Laval type at high temperatures without injury to the bearings, nozzles, or blades. Thus the machines subsequently used in these tests were operated with steam superheated to a temperature of 530° C., without injury, and temperatures of 400° C. were readily maintained continuously without producing any injurious effect either upon the superheaters or machines.

Experiments upon the use of highly superheated steam in turbines have shown that it is possible to use to advantage steam temperatures which leave the exhaust steam to be discharged at a higher temperature than that of the boiler. Under such conditions it is evident that a gain will result if this exhaust steam is passed through the boiler and permitted to return its excess heat. The steam, then being at boiler temperature, may still be used to give the feed water a preliminary heating, before entering the condenser. It is evident that the exhaust steam from a turbine, if itself still somewhat superheated, is well adapted for use in a low-pressure turbine, and when a steam reheater between the two turbines is used, there may yet be sufficient heat left in the final exhaust to be worth returning to the boiler before passing to the feed-water heater. Such is the line of experiments conducted at the Dresden laboratory, and from the paper above referred to, in which the details of the arrangement are fully described, and the logs of the tests given, the final results are taken.

In the first series of tests a turbine was operated non-compound both at low and high pressure, with superheating to 400° C., using the regenerator to abstract the excess heat from the exhaust. Under these conditions, with a steam pressure of 1.4 atmosphere absolute, and a condenser pressure of 0.1 atmosphere (initial pressure

about 5 pounds per square inch, and vacuum 27 inches of mercury) the result was a steam consumption of 8.22 kilogrammes per horse power per hour, or 18.1 pounds. With an initial pressure of 7 atmospheres, or about 100 pounds, the vacuum remaining the same, the steam consumption fell to 6.58 kilogrammes, or 14.5 pounds, per horse power, the steam being superheated to 400° C. as before; these corresponding to thermal efficiencies of 8.7 and 10.6 per cent. respectively.

With the compound arrangement the initial pressure was raised to 13 atmospheres, or 185 pounds; the pressure of admission to the low-pressure turbine being 1.2 atmosphere, or about 3 pounds per square inch, the vacuum being kept at 27 inches. Trials were made under these conditions, with steam superheated to 300° C. and to 400° C., the result being, in the first case a steam consumption of 5.89 kilogrammes, or 12.96 pounds; and in the second case 5.07 kilogrammes, or 11.15 pounds per horse power per hour; these corresponding to thermal efficiencies of 11.5 and 13 per cent. With an initial pressure of 16 atmospheres, and a temperature of 300° C. before the high-pressure turbine, and 500° C. reheating before the low-pressure turbine, and a vacuum of 28.5 inches, it is believed that a thermal efficiency of 18 per cent. may be attained, practically equal to that of the average gas engine.

INDUSTRIAL ENGINEERING MANAGEMENT.

THE ENTRANCE OF THE ENGINEER INTO THE COMMERCIAL AND INDUSTRIAL DEPARTMENTS OF PRODUCTION.

Hugo Diemer—Indiana Engineering Society.

DURING the past fifteen or twenty years there has occurred a veritable transformation in the matter of the industrial management of manufacturing establishments. Formerly the dividing line between the engineer and the business manager was drawn hard and fast and neither thought of attempting to overstep the limit. To-day it is realized that unless a proper combination is made of commercial and engineering methods the prospect for success is an industrial undertaking is exceedingly remote. In a paper presented before the Indiana Engineering Society by Mr. Hugo Diemer this subject of industrial engineering is discussed in an interesting manner and some comments upon his discussion of this important subject are here given.

After referring to the early discussions of the matter, including the reluctance of both engineers and business men to admit the work of each other to their respective domains, Mr. Diemer calls attention to the fact that the recently elected President of the American Society of Mechanical Engineers, Mr. F. W. Taylor, was one of the earliest advocates of modern industrial engineering, and that he stands to-day among its foremost representatives, this indicating more clearly than any discussion the present attitude of the engineering profession towards the subject of modern works management.

"As early as 1889 Mr. Taylor earnestly pleaded that shop statistics and cost data should be more than mere records and that they in themselves constituted but a small portion of the field of investigation to be covered by the industrial engineer. While he did not so express himself the gist of his treatment of factory management is this: He considers a manufacturing establishment just as one would an intricate machine. He analyzes each process into its ultimate, simple elements and compares each of these simplest steps or processes with an ideal or perfect condition. He then makes all due allowances for rational and practical conditions and establishes an attainable commercial standard for every step. The next process is that of attaining continuously this standard involving both quality and quantity and the interlocking or assembling of all of these prime elements into a well arranged, well built, smooth running machine. It is quite evident that work of this character involves technical knowledge and ability in science and pure engineering, which do not enter into the field of the accountant. Yet the industrial engineer must have the accountant's keen perception of money value. His work will

not be good engineering unless he uses good business judgment. He must be able to select those mechanical devices and perfect such organization as will best suit present needs and secure prompt returns in profit. He must have sufficiently good business sense to appreciate the ratio between investment and income. He must be in close enough touch with the financial management to be able to impress upon them the necessity of providing sinking funds to provide for the more perfect installations and organizations which future demands of a more educated and enlightened public will necessitate."

There are few business men to-day who would seriously consider entering upon any important undertaking without competent legal advice, and the old saying about the status of the man who undertakes to be his own lawyer is well known and often quoted. The consulting engineer to-day occupies a similar position in many instances to the legal adviser. This has long been the case with the mining engineer, and upon his examinations and reports great investments and undertakings are continually being made. The industrial engineer does more than this, he not only reports upon the present value or lack of value of a manufacturing enterprise, but he shows how a wasteful management may be converted into an economical one, or how apparently disastrous competition may be successfully met.

"The word production indicates the making or manufacturing of commodities. Engineering as applied to production means the planning in advance, of production so as to secure certain results. A man may be a good mechanic but no engineer. The distinction between the mechanic and the engineer is that the mechanic cuts and tries, and works by formulæ based on empiricism. The engineer calculates and plans with absolute certainty of the accomplishment of the final results in accordance with his plans, which are based ultimately on fundamental truths of natural science.

"It is the business of the production engineer to know every single item that constitutes his finished product and every step involved in the handling of every piece. He must know what is the most advantageous manufacturing quantity of every single item so as to secure uniformity of flow as well as economy of manufacture. He must know how long each step ought to take under the best attainable working conditions. He must be able to tell at any time the exact condition as regards quantity and state of finishedness of every part involved in the manufacturing process.

"The engineer must be able not only to design, but to execute. A draftsman may be able to design, but unless he is able to execute his designs to successful operation, he cannot be classed as an engineer. The production engineer must be able to execute his work as he has planned it. This requires two qualifications. He must know men and he must have creative ability in applying good statistical, accounting and system methods to any particular production work he may undertake.

This question of the management of men is a vital one, and one which includes not only a familiarity with economic and sociological subjects, but also that familiarity which comes of actual experience and contact with mechanics in all departments of their work.

"A manufacturing organization being a live, human thing, is like a municipality. Many of our shops are as fruitful fields for riddance of graft as are many of our cities. The graft in the shop consists mostly in the distortion of the managing and planning body into a wire-pulling and influence machine with easy berths filled by incompetents or idlers. This condition often exists not because of any intentional desire to be disloyal on the part of the employees, but simply on account of the work being allowed to drift without systematic attention to departmental organization."

It must be clearly understood that the best system and the most ingenious mechanical appliances will not make men honest, and that one can no more create integrity by machinery than by legal enactment. Cases are well known in which grafting foremen have deliberately utilized mechanical recording devices to make deceptive records, using their authority and opportunity to divert a good system to their own dishonest ends. In this respect works management does not differ from any other department of business, and similar conditions obtain in both cases.

"The owners of an industrial establishment can do no wiser thing than to sit down and prepare a graphical chart showing their organization by departments and in detail as it really exists and then prepare or have prepared for them another graphical chart, showing that organization from a wholly impersonal standpoint, which would be the most effective for plant efficiency. When manufacturers once get so far as to prepare and compare such charts and see the opportunities for improvement, they will not hesitate long to take advantage of them. It would be the height of folly to say that such improvement is possible in every manufacturing establishment, since herein lies the secret of greater effectiveness and higher profits of many an establishment over its competitors in the same line of business. This very fact, however, should be the best reason for manufacturers to prepare such charts, which act as mirrors in giving them a true picture of themselves."

Mr. Diemer discusses at length the educational side of industrial management, showing the extent to which the question is already treated in the technical schools and colleges, and indicating the lines along which, in his judgment, further improvements may be made. Concluding, he calls attention to the important fact that the whole matter should be based upon the position of practical economy and money-making, and not upon that of philanthropy or advertising.

"The owners of progressive industrial corporations are beginning to realize that the financial returns from good organization, good production methods, good successful merit wage systems and the development of human efficiency are so great that they can afford to pay better salaries than have been the rule in the past to department heads and foremen provided they are properly trained by education and experience to accomplish results. The more progressive shop owners are beginning to realize that the question is one of engineering. The expert accountant, the system man, the salesman for system appliances, are but partially equipped by education or experience to undertake the work of production engineering. The qualifications required include all of the good ones which these men have. In addition to possessing these qualifications a competent expert in industrial management and production engineering must be a thorough mechanical engineer, technically educated, broad minded, with creative and executive ability, with the system man's knowledge of accounting and statistical methods and with wide experience in economic and labor questions. There will be an increasing demand for men with these qualifications and there is no danger that there will be an over supply."

PROGRESS IN SPACE TELEGRAPHY.

A REVIEW OF RECENT ADVANCES IN THE TRANSMISSION OF COMMUNICATIONS THROUGH SPACE BY ELECTRIC WAVES.

J. Erskine Murray—Institution of Electrical Engineers.

ALTHOUGH there have been few announcements of a startling nature of late concerning the development in the electric transmission of messages through space, the subject has been making steady progress, and at the present time wireless messages form a regular portion of the communication service of the community. In a paper presented before the Glasgow section of the Institution of Electrical Engineers by Dr. J. Erskine Murray, a review is given of recent advances in space telegraphy, together with some discussion as to the theory according to which the phenomena may be explained.

By far the greater number of installations at present in operation are used in connection with passenger steamships for communicating with the shore and with each other, and for this purpose the untuned coherer system of Marconi is principally employed, sometimes with minor variations and under other names. Untuned systems are being displaced by tuned systems, but the comparative simplicity and ease of working of the former have led to its extended use for distances under 150 miles. Dr. Murray explains that the reasons for the limitation of the Marconi untuned system to distances of about 150

miles is due to the fact that at such distances the lines of force from the charge on the aerial wire have time to reach the receiving station before the spark occurs at the transmitter.

Under such conditions it is only necessary to have an electrostatic charge suddenly discharged, either with or without oscillations.

The action under such circumstances is described by Dr. Murray as follows: "The aerial wire is charged, say positively, and lines of electric force spread out from it, having their negative ends on the earth surface all round, some of them ending on the aerial wire of the distant receiver. When the electrical pressure has become so great that the spark jumps across the gap between the aerial and the earth wire there is a sudden change in the distribution of electricity. The negative spread out over the earth or sea and on the aerial of the receiver rushes in toward the positive, producing a current of quite appreciable voltage, though of very short duration, and it is this current which actuates the receiver in passing through it from the aerial wire to the earth."

Under such conditions it is evident that any receiver within range will be affected, and there is no practicable way of preventing interference, so that some other system or some modification must be employed for selective or tuned transmission.

"The methods of discrimination or tuning now employed in almost all systems depend on the principle of the superposition of small motions. In wireless telegraphy, tuned systems, and, indeed, long-distance transmission in general, depend on this phenomenon. The moving masses are masses of electricity, and the dimensions regulating their frequency of oscillation are the inductance, capacity and resistance of the circuits in which they move. Thus, if a series of small electrical impulses or waves arrive at a receiving station, each impulse being timed so as always to increase the motion of electricity in the receiving conductors, an oscillatory current will be generated of rapidly-increasing amplitude, which stores up the energy arriving until the current becomes great enough to actuate the receiving mechanism. The most obvious application of this principle to telegraphy is the discrimination between a group of sending and receiving stations by giving the members of each pair, which are intended to communicate, the same electrical dimensions, so that a transmitter, and the receiver it is intended to communicate with, have the same natural frequency. This plan has been adopted by almost all inventors, and works well. The principle has been wonderfully developed, the most strikingly successful result being that obtained by Capt. Jackson, R.N., who this year, while receiving messages from a ship at a moderate distance on the mainmast of H.M.S. *Vernon*, was simultaneously transmitting messages from the foremast to another vessel 500 miles off. This result was rendered possible by an alteration in the original Marconi receiver, which, though apparently small in itself, was of far-reaching importance. In the old receiver the coherer formed a gap of enormously high resistance between the aerial and earth wires which effectually prevented any oscillation in the receiver except the small current which might occur through the coherer plugs acting as a condenser. The coherer was simply cohered by the voltage produced in the aerial. In the new receiver the aerial wire was connected to earth through the primary of a small transformer, thus providing a path of low resistance in which oscillations could grow in amplitude as the impulses from the transmitter arrived, and a secondary circuit which could be made exactly equi-frequent with the oscillations arriving from the distant station. It rendered discrimination practicable, while at the same time it enormously increased the distance over which transmission could take place, by utilising the energy of all the waves arriving instead of only that of the first. The transmitter was next improved by the introduction of more capacity and inductance, enabling it to give out a much longer train of waves, of which, perhaps, 30 or 40 are of useful amplitude, instead of two or three in the earlier form.

The oscillations required for tuning may be produced by various methods, that most generally employed being the use of a separate circuit, as devised by Tesla. Dr. Murray describes the modifications as made by Lodge, Muirhead, and Marconi, and in gen-

eral he divides the transmitters into two classes: those in which the natural oscillation frequency of the aerial wire is utilised; and those in which the oscillation in the aerial is a forced one, its frequency being determined by a very persistently oscillating circuit coupled to the aerial.

At Poldhu and in his other transatlantic stations—the most recent being that in course of erection near Roundstone, County Galway—Mr. Marconi employs a large number of aerial wires, arranged like an inverted pyramid, all being connected at the vertex to the generating circuit and to earth. A very large electrified surface and capacity is thus obtained with the use of a very moderate quantity of conductor. At the same time the electric lines of force commence at a considerable elevation above the earth, thus facilitating their wide distribution and ensuring a sufficiently long wavelength. The wires are spread out, which gives a free path for the lines of force from each to earth, giving practically a greater capacity to the system than if they were bunched t gether, in which case the inner wires of the bunch would be nearly useless. The generating system contains a Tesla circuit operated by an alternator and coupled to the aerial. The receiver generally used for long distances is the form of magnetic detector, based on Rutherford's experiments and designed by Mr. Marconi. This receiver is very sensitive, and, as it contains a completely closed circuit, should be susceptible of very accurate tuning leading to a further increase of sensibility.

"Mr. Fessenden uses a single aerial conductor, a great sheet iron tube like a factory chimney about 420 ft. high. Long trains of waves of what may, for wireless telegraphy, be called low voltage, are transmitted, and receiver and transmitter have frequencies which are very exactly equalised. The transmitter to be used for transatlantic work is apparently that most recently patented by Mr. Fessenden. It is practically an alternator with one terminal connected to the aerial and the other to earth. Possibly other circuits may be introduced, but no information has so far been published. The advantage of this transmitter is that an indefinitely long train of waves of equal amplitude may be emitted. If the receiver be exactly equi-frequent, the energy of each wave may be very small as their effect is cumulative. Another patent of Mr. Fessenden's describes a system in which two trains of waves of different frequency are transmitted by one aerial, the receiver being only actuated when waves of both frequencies are simultaneously received. This system opens up great possibilities in regard to discrimination between different stations, as the combinations of two variable quantities—*i. e.*, the frequencies of both sets of oscillations—are involved instead of only the frequency of one set. A similar system has been patented by Braun.

Dr. Murray reviews some of the recent patents, including those of Artom, Marconi, and Blondel, and discusses the action of the coherer and the transmitter. In this latter connection he calls attention to the fact that modern wireless telegraphy is not true radiation, since the Hertzian waves, unguided through space are nearly all lost by passing out into space, and have been used for telegraphing over distances of only a mile or two. When Marconi connected the lower ball of his Hertz radiator to the earth he made the whole earth the lower ball. This made the earth and the aerial the two conductors of an oscillator which is so unsymmetrical that it radiates very little indeed, the oscillations simply spreading from their point of generation over the two conductors.

"The propagation of a hemispherical electric wave, in which the lines of force have their ends on a conducting plane surface has been investigated by Heaviside, and from a wireless telegraphist's point of view by Blondel. Neglecting the curvature of the earth, the form of the wave is approximately the same as would be produced by removing the earth and putting another wire downwards from the spark-gap, this wire being equal in length to the aerial, and oppositely charged at every moment. If the electric wave used in wireless telegraphy retained this form we should find that the currents resulting from their action on the receiving aerial would vary inversely as the square of the distance. This does not, however, agree with Duddell and Taylor's measurements—the only definite measurements as yet published—of the variation of the received current with distance. They find from experiments made between a sta-

tion at Howth and H.M.T.S. "Monarch" in the Irish Channel, that the current at distances beyond 10 or 15 miles varies in almost exactly simple inverse proportion to the distance between the stations. This result admits of no question, the experiments having been carried out most carefully and with wonderfully concordant results. We must, therefore, accept the fact and look for an explanation in some circumstance which modifies the hemispherical waves given out by the transmitter when they attain a radius of about 10 miles.

"I find that there is an explanation lying ready to our hand, which is based, not upon theory, but on the well-ascertained facts of the nature of our atmosphere. Put briefly, it is as follows: If the earth were surrounded by a spherical shell of conducting material it is a well-known fact that the waves would not die away in proportion to the square of the distance, but would vary, for moderate distances, in inverse proportion to the distance itself. Now, recent researches on auroræ by Danish observers have proved that these occur sometimes as low as 6 miles above the earth's surface and never at a greater height than 60 miles. An aurora is an electric conduction current; hence the layer of air between 6 and 60 miles above the earth is conductive. Here we have, then, the explanation of Duddell's law of variation with distance. The approximately spherical wave given out by the oscillator rises till it touches the conducting layer, then becomes annular, and travels outwards with a wave-front, the area of which no longer increases as the square of the distance, but only in proportion to the distance itself, since the wave is confined by the parallel conducting surfaces above and below. Thus the only space variation which causes diminution in strength is the increasing radius. There is, of course, in addition, a frictional loss of energy."

Dr. Murray concludes his paper by an examination of the phenomenon of the great range of transmission by night than by day, showing that this must be due to some variation of the electrical properties of the atmosphere by the rays of the sun.

MECHANICAL TIME KEEPERS

THE USE OF MECHANICAL RECORDING DEVICES IN SECURING ACCURATE RECORDS OF TIME CHARGES UPON TECHNICAL OPERATIONS.

Henry Abbott—Telephony.

WITH the general introduction of modern cost-keeping methods the necessity for securing accurate and indisputable time records has become fully appreciated. This is true of many branches of industry, but in no department of work are such records more essential than in the telephone exchange. In the early days of telephony the system of yearly subscriptions, worth an unlimited number of calls, was generally employed. With the development of the long-distance service the method of charging by separate tolls became necessary, the toll depending upon the distance and upon the time the wire was in use, the time element originally being computed upon five-minute intervals.

At first the time charges were taken by the attendant at the central exchange, simply by observing the clock and noting the times of the beginning and ending of the conversation, these observations being checked by comparison of the records at both the transmitting and the receiving stations. As the business extended it became evident that some better method was necessary, both as a matter of operative economy and to secure indisputable accuracy. In an article in a recent issue of *Telephony*, Mr. Henry Abbott discusses the introduction into the telephone service of the calculagraph, the time recording instrument now widely used for the purpose of making the time records for telephone calls.

The use of mechanical time-recording devices is by no means new, and many varieties of such apparatus have been made and are in use. Probably one of the best-known forms is the ordinary time-stamp, which simply notes the actual hour upon a card, envelope, or piece of paper upon which the stamp is impressed. Such instruments are now very generally employed in clubs, hotels, and similar places to establish beyond

doubt the hour at which a call has been made or a message received, and in this way a fruitful source of errors and complaints has been eliminated.

A further extension of the same idea appears in the different kinds of time recorders for use in manufacturing establishments for checking the time of the arrival and departure of employees, and there are few workshops of importance where such recorders are not found. In fact, many modern establishments have mechanical time recorders placed in each work room, thus subdividing the records, and enabling them to be examined more intelligently, while many mercantile establishments, both wholesale and retail, use the same method of accounting for the time of their employees.

A number of years ago the idea was suggested, by Mr. W. S. Rogers, we believe, of using the mechanical time recorder in connection with the determination of time charges on job tickets, the ticket being passed through the machine or under the time stamp when the work was given out, and again when the finished job was turned in, the difference between the two times showing the elapsed time in a manner beyond any juggling by the employee. The sum of the times recorded against any workman should agree within a reasonable degree of closeness to the total time of the man on the pay-roll, and any great discrepancy would indicate time wasted between jobs.

In the case of the telephone record, however, something more was required, and the instrument devised by Mr. Abbott for this service, and described at length in his paper, records not only the precise hour at which a lever is pulled, but also the elapsed time between a first and second manipulation, the machine performing the subtraction automatically. This does away entirely with any human intervention, and removes the personal element altogether, the work of the operator being limited to the insertion of a card into the instrument and pulling a lever, this operation being repeated at the termination of the service. For telephone work the calculagraph is graduated to read to single minutes in recording the elapsed time, but such a degree of precision is not necessary for shop job records, and the graduations may be modified to suit the service.

There is much to be said in favor of such mechanical time-recording devices, and for all operations which are conducted strictly on a time basis a machine is preferable to any human timekeeper. A mechanical record is free from bias, error of judgment, or favoritism, and apart from the saving in the time of the operator or workman it practically removes all source of dispute or disagreement. Records which can be accepted as wholly reliable may be used with confidence in readjustments of rates or methods, while processes and systems of work may be tested beyond the reach of prejudice or doubt when the timing is performed independently and mechanically.

The widespread introduction of such mechanical time recorders is testimony to the acceptance of the modern theory of production, that human effort is to be directed, as much as possible, toward the direction and guidance of operations performed by machinery, everything of a mechanical nature being performed mechanically, so far as possible, reserving for man the exercise of judgment and discretion.

THE LAKE SUPERIOR IRON-ORE DEPOSITS.

EXPLORATION AND DEVELOPMENT WORK ON THE IRON-ORE RANGES OF THE LAKE SUPERIOR DISTRICT IN 1905.

Dwight E. Woodbridge—Iron Age.

WITH the close of the year 1905 there has come the usual review of the various natural resources of the United States, and among these there is none more impressive than that relating to the iron-ore supply of the Lake Superior district. From this district the United States Steel Corporation draws the greater part of its supply of raw material, while upon the control of certain portions of these ranges depends in great part the ore-carrying business of large railway inter-

ests. In recent issues of the *Iron Age* the trade of this district is discussed by Mr. Dwight E. Woodbridge, a review being given of the output for the past year, together with an indication of the developments.

During the year 1905 the shipments from the district reached 34,000,000 tons, being more than 12,000,000 tons greater than those of the preceding year, a gain of about 57 per cent., or a gain of more than 60,000,000 gross tons in excess of the greatest previous year. Of this enormous tonnage more than 20,000,000 came from the Mesaba range, the balance being divided among the Menominee, Marquette, Gogebic, Vermillion, and Michipicoten ranges.

"The vast tonnage shipped in the past season was seemingly so easily moved and sent forward with so little friction that it is difficult to believe that in no year during the life of the Mesaba range had there been such obstacles to the free movement of ore from mines, nor had the mining companies and railroads ever worked under such difficulties and discouragements. As the Mesaba range furnished about 60 per cent. of the total ore moved to lower lakes in 1905 any derangement there had an effect far more than ordinarily important and far reaching. Time after time during the entire summer there were disastrous floods; the heavens seemed to open and pour out upon the heads of the struggling operators such rains as had never been known. Time after time were the open pit mines of the range—those very properties upon which the mining companies had depended for their great shipments—buried so deeply in lakes and rivers of water that even the booms of the steam shovels were invisible. For three months these floods succeeded each other with a disgusting regularity and frequency.

"Shipments for single railroad systems were extremely large. The Duluth, Missabe & Northern, which serves mines upon a portion of the Mesaba range, handled to its docks in the month of July, 1,408,000 tons, or 50,000 tons per day, and averaged during the entire season of navigation better than 1,000,000 tons each 30-day period. The Duluth & Iron Range, serving the entire Vermillion and a portion of the Mesaba range, moved during the year a trifle below 1,000,000 tons per month, while the Chicago & Northwestern, with docks at Escanaba and Ashland, had a gross business at both points of about 6,000,000 tons. A departure in traffic conditions was made during the fall by the Wisconsin & Michigan Railway, which opened its ore line to points on the Menominee range, hauled ore from mines to docks at Peshtigo on Lake Michigan and transported it from there to furnaces at Chicago and elsewhere on modern car ferries, each capable of carrying a train of loaded cars. The innovation of utilizing ferries to move loaded trains, thus obviating ore piers and saving 280 miles of railroad, which was replaced in this company's scheme by the free highway of Lake Michigan, is an interesting method of long distance transit. The car ferry for crossing great lakes and for moderate distances has long been in favor, but this is the first time any such system has been adopted in lieu of main line long distance traffic, and the result will be watched with some interest."

In view of the rapid development which is being made in the district it is interesting to observe that some of the independent interests are acquiring ore reserves, so that the whole region is by no means controlled by the Steel Corporation. Thus, the Hill interests, including those of the Great Northern Railway, hold a number of important leases, including the Mahoning mine, estimated to be capable of producing 1,000,000 tons a year for 60 to 75 years, but this, and other mines, classed as Hill holdings, are really leaseholds, thus being valuable payers of royalties, and furnishing profitable hauling, but not open for disposal during the life of the leases.

"Exploration during 1905 has been more general than for some time. It has not been confined to the Mesaba, but has extended to the once-promising Vermillion, to the Menominee and to parts of the Marquette and Gogebic ranges. Deep shaft sinking on the last named range is opening ore deposits that give the brightest promise for the future, a promise of maintaining the output of the district at a steady price for many years. Drilling on parts of the great ore bearing formations of the Menominee range is opening a few mines of importance and is giving hope for more. Though immense sums have been spent in

the Vermillion in past years with the diamond drill no large deposits have ever been found aside from the Soudan and Ely groups. Now a number of drills are at work elsewhere. On the famous Section 30-63-11, where drill work had been carried on for three years, a shaft is now dropping slowly through the hard jasper and iron formation of that difficult region. At this prospect some ore has been found, and it is probable that the deposit may pan out as a very fortunate discovery.

"In what is known as the Austin, Swanzey and Palmer districts of the Marquette range explorations during the year have revealed what may be of great importance. There are in these districts immense bodies of low grade ores, highly silicious, some well within the Bessemer limit as to phosphorus and others highly in that element. Hundreds of millions of tons of fair ores are known to exist about Palmer, as well as in other parts of both the Marquette and Menominee ranges, which will be wanted in due time and are advantageously located as to freight charges."

Among the new districts in which developments may be expected, Mr. Woodbridge notes the Deerwood or Cuyuna range, about 100 miles west of Duluth, the Baraboo range, and the Atikokan range, in western Ontario, while he states that steps have been taken for the immediate development of the Moose Mountain region, north of Georgian Bay, in Canada, where there are large deposits of magnetite.

"In preparation for the operations of 1905 as well as for 1906 an enormous quantity of dead work has been carried forward. On the Mesaba range alone stripping contractors and mining companies have moved in 1905 above 6,000,000 cubic yards of overburden, one contracting firm alone removing more than 2,600,000 yards. On this range the evolution from underground to open pit, before referred to, has been general and with accelerated speed. It is now no bar to stripping that a mine is covered by 100 feet of overburden of boulders, hardpan, drift or ledge. It is all rolled back and carried off, providing the ore deposit is of sufficient thickness to make the subsequent mine operations economical. Many a Mesaba mine which has been operated underground from the beginning is to be stripped; indeed, many have already been changed from one system to the other. The Oliver Iron Mining Company alone is buying this winter an additional stripping and mine equipment of 65 standard gauge locomotives and 25 steam shovels, which is an indication of its plans for changing to open pit and mining by shovel. There will be, at the opening of 1906, not less than 120 heavy steam shovels working on this range."

With all this development in the iron ore trade there naturally follows preparations to handle this enormous tonnage on the lakes. It has been estimated that for the five years ending with 1910 the average shipments may readily be 40,000,000 tons per year as against 25,000,000 tons for the preceding five years. This means that the 4,000 to 5,000 ton boat will be replaced by carriers of 10,000 to 12,000 tons, reaching 600 feet in length, and constructed with the combined experience of both the owners and lake shipbuilders.

ENGINEERING EFFICIENCIES.

THE PRACTICAL MEANING OF EFFICIENCY AS APPLIED TO THE COMMERCIAL SIDE OF ENGINEERING UNDERTAKINGS.

James Swinburne—Institution of Electrical Engineers.

IN an interesting address, delivered before the students of the Manchester Local Section of the Institution of Electrical Engineers, Mr. James Swinburne talks about the efficiencies of commercial and engineering undertakings, using the term in the plural, as he explains, in order to avoid any possibility of confusion with the term "efficiency" as employed in the parlance of party politics.

Mr. Swinburne is generally to be depended on to state his views in a positive, and even dogmatic way, but he has a refreshing frankness about it which makes interesting reading, even when the reader does not always agree fully with his views. It seems very desirable, for instance, that the precise technical meaning of the term "effi-

ciency" should be settled and accepted, but this happy conclusion has by no means yet been attained, and we have the German engineers disputing about the true meaning of *wirkungsgrad,* while the French *rendement* has to be qualified in nearly every case to make sure that the writer's meaning is conveyed. In any case, however, there is no doubt that each one of these terms conveys the idea of a ratio, expressible as a percentage, so that the points usually under discussion are those relating to the quantities between which the ratio is taken, and in this respect Mr. Swinburne makes himself clear, even when he boldly announces his unorthodoxy.

Mr. Swinburne says that the term efficiency is used by serious people to denote the rate of the useful part of the energy or power obtained, to the energy or power put in, which is indeed true, but there are various differences of opinion as to what portions of the result are to be considered as useful, and hence corresponding differences in the value of the numerator of the fraction. This difference of opinion is brought out by Mr. Swinburne at the start, since he says that in a well conducted bargain each of the parties gives what he prefers to part with for what he wants more, so that both are satisfied. If each man gets out more value than he puts in each gets an efficiency of more than 100 per cent. out of the trade and, as Mr. Swinburne again says, it is not quite usual for a bargain to have an efficiency of more than 100 per cent. from each point of view. However, from the Oriental viewpoint it has been said that a profit of 10 per cent. is understood to mean the sale of an article for ten times what it cost the seller, so that a preliminary statement of the writer's point of view is almost necessary if his position is to be understood. Fortunately Mr. Swinburne explains what he means as he goes along, which is quite convenient.

After discussing a few examples of efficiency in monetary transactions, Mr. Swinburne proceeds to some technical examples of efficiency.

"In making any bargains with Nature, we always lose in a sense; and we are so accustomed to it that we take it quite contentedly, and merely try to lose as little as possible in the transaction. As I said before, the relation of what we do not lose to the whole is termed the "efficiency." In dealing with our fellow men we always hope to make a profit, and we sometimes do. In such a case it might be correct to talk of an efficiency of over 100 per cent., but it would be unusual. It might be still more unusual to say a bankruptcy which resulted in a payment of 6s. 8d. in the £ was a transaction with an efficiency of 33 1/3 per cent. But there would be enough justification for such a proceeding to enable me to discuss some aspects, even of electrical commerce, under the head of efficiency.

"Heat includes what is called sensible heat, or heat that makes things hot; latent heat, such as the heat that disappears when ice is melted or water vaporised at constant temperature, and chemical energy. I must tell you that it is not orthodox to call chemical energy heat; and you will not find any such treatment of the subject in books on thermodynamics. At present I believe I am alone in classing chemical energy or defining heat so as to include chemical energy; but the treatment of chemical energy in chemical thermodynamics is quite consistent with my definition, so I may use it provided I give you due warning of any heterodoxy. I think that it is not realised that chemical energy is necessarily low-grade energy, only partially convertible into work. This involves the idea of chemical temperature which may be important in chemistry in discussing the way any given possible reaction will go; but we are not concerned with that here. It will be said that the coal is cold when it is put into the furnace, as cold as the air in fact; so that if this idea is right none of the chemical energy is available. But I must give some idea of what I mean by chemical temperature. If carbon and oxygen are heated to a high enough temperature you get a state in which on the least fall of temperature the carbon and oxygen combine and give out sensible heat at that temperature, under the other circumstances that obtain. The least increase of temperature, however, causes the carbon and oxygen to separate again, absorbing sensible heat. At this temperature, therefore, under the pressure and quantitative relations of the carbon, oxygen, and carbon monoxide, sensible heat

and chemical energy are interchangeable. This temperature may be called the chemical temperature of the energy of carbon and oxygen.

"It might be supposed that there is enormous room for improvement in the steam engine. An efficiency diagram looks as if all the loss is due to the engine which gets 68 per cent. and only gives out 7 per cent., but we must not be hard upon the engine. It is turning out work, or high grade energy, and it is receiving heat, or low grade energy. This engine is probably taking in steam at about 450° C. absolute, and rejecting it at about 375° C. A., so it could if perfect only turn out $68 \times 75 \div 450 = 11.3$; so it is not really doing so badly. The real loss is between the fuel and the boiler, and it is not loss of energy, but loss of availability. Though the chemical is low grade energy, it has such a high chemical temperature that 97 per cent. is theoretically available; but we cannot run a boiler and engine between 3,000° C. and 4,000° C. Engineers are always trying to improve the results by using higher and higher temperatures; but as you cannot use the pressures that would then correspond with saturated steam you can only superheat. This does not mean that most of the heat is taken in at the high temperature, and the resulting gain is chiefly due to such things as reduction of cylinder condensation. There are great practical difficulties in reducing the lower temperature. The condenser reduces it to about 100° C. or 373° C. A.; but even then the steam is not completely expanded, and blows into the condenser under pressure."

Mr. Swinburne refers, in passing, to the fact that the temperature of rejection has been lowered recently by the use of a second fluid medium, such as sulphur dioxide, an idea which is as old as the days of Sir Humphry Davy, and which has been tried in various forms since without much success, mainly owing to mechanical and operative difficulties.

An interesting portion of the address relates to the management of municipal electrical undertakings, in connection with which some diagrams are given showing the manner in which the efficiency of the Metropolitan Electric Supply Company's system varies according to the load. This gives Mr. Swinburne opportunity for an interesting disquisition upon the subject of municipal undertakings in general.

"If a station is run by a town the accounts must be kept by an absurd system. Towns are generally concerned with such things as sewage systems, in which there is no profit and loss account. The town may not treat its sewage system as a permanent asset at all. It has to borrow money to put down its sewage system, say £100,000 at 3 per cent. Then it has to pay £3,000 a year interest. But that is not all—it has to pay back the whole £100,000 in a certain number of years. To do this it has to provide out of the rates a sinking fund, such that in the prescribed term of years the whole of the debt is paid off. The town then has a sewage system to the good, which has been paid for over many years out of the rates. The town, therefore, does not save money like the private individual and then buy what it can afford. I do not think that it would be allowed to do such a rational thing; it has to borrow money for everything and pay it back over a term of years. The length of the term has no reference whatever to the nature of the work done, as the work is not in any way security for the loan; the local rates are the security. There is an epidemic of outcry just now about municipal indebtedness, but it is apt to give a totally wrong impression to the average reader, as he does not realize that municipalities must be in debt owing to the way these things are arranged. For a private individual always to be in debt would be bad; for a town it is another matter; the only question is how much the town ought to be in debt. The nation itself does business in the same sort of way; it has no ready money, and when anything has to be done it borrows. But local authorities are now taking up such businesses as electric supply and tramways, which have profit and loss sides, but they are obliged to work the businesses on the same lines as town improvements, which is absurd. A municipal electric light scheme is thus worked under absurd difficulties. It is like a public company that has a negative capital—that is to say, all its money is borrowed. The shareholders are the ratepayers. They hold shares depending on the rate assessments. The dividends are

generally negative. All the shareholders are so by compulsion if they live in the place. The only thing they can do if they do not want to be shareholders in such undertakings is to move off to another town; but then they become shareholders in another set of ventures. I believe the only way to avoid being shareholders in these compulsory undertakings it to live in a barge on a canal."

THE GAS TURBINE.

THE PRESENT STATUS OF THE QUESTION OF A PRACTICAL SOLUTION OF THE GAS-TURBINE PROBLEM.

A. Berthier—Le Génie Civil.

ALTHOUGH the gas-turbine problem has been under consideration for several years, and has occupied the attention of a number of able engineers there has been little or no practical progress, at least so far as can be gathered from the detailed results which have been made public.

In a recent issue of *Le Génie Civil* there is given a résumé of the present status of the question on the Continent in a paper by M. A. Berthier, from which some abstract is given as being of present interest.

After referring to the fact that piston gas engine and the steam turbine each represent the latest achievements in their respective departments of motive power, M. Berthier sees in the gas turbine a possible union of these two systems, a machine uniting in one mechanism the advantages of both.

The earliest attempt to construct a gas turbine appears to be that of Stolze, of Charlottenburg, who, as long ago as 1873, took out a patent for what may be termed a hot-air turbine. As a matter of fact the ancient mechanism for operating the turnspit, consisting of a sort of propeller wheel on a vertical axis, fitted in the chimney, and driven by the force of the ascending current of hot air and smoke, preceded any other machine of the kind, but we cannot ascertain either the date or the inventor of this early device.

The Stolze turbine consists practically of two turbines mounted upon the same horizontal shaft, the one acting to draw in and compress the air to about 2½ atmospheres, absolute, this compressed air then passing partly through a furnace and partly through a heating chamber, the hot air, mixed with the gases of combustion, passing through the turbine. The available power is the difference between that developed by the turbine and that required to drive the rotary compressor. A turbine of 200 horse power has been constructed on this plan, and experimental trials are being made as to its performance. The Stolze turbine practically follows the same cycle as the ordinary internal-combustion engine: compression, carburation, combustion, expansion, exhaust, the only difference being that the mixture of the air with the combustion is not effected until after the compression, as is the case with the Diesel motor.

Considering the Stolze turbine rather as a hot-air motor than a gas-turbine, M. Berthier passes to the later plans for turbines using gas or petroleum as fuel. These machines are based upon the combustion of the fuel in a closed chamber at constant pressure, the pressure of the gaseous products of combustion being converted into velocity in the turbine nozzle. The designers of such machines have generally assumed that the use of a nozzle and wheel of the de Laval type is practicable, and devoted themselves to the production of a suitable combustion apparatus.

M. Berthier gives, as an example of a combustion chamber for a turbine, a sketch of the Meineke device, this having separate entrances for the air and gas, the combustion taking place at constant pressure, the expansion being effected wholly in the nozzle. M. Meineke advocates the use of a cycle composed of four phases, the heat being furnished and rejected at constant pressure, the expansion and the compression being adiabatic.

It does not appear that any actual operative machine has been constructed on the plan of M. Meineke, but M. Berthier passes to the mixed steam and gas turbine of Armengaud and Lemale, which, as has al-

ready been noted in these columns, has been actually built and run. The principal characteristic of this appearance lies also in the combustion chamber. The air and the liquid fuel enter through concentric nozzles at one end, while a circulation of water in the lining of the chamber protects it from destruction by the high temperature.

The supply of cooling water is so regulated that it is raised to the boiling point and delivered in the form of steam to mix with the gases of combustion in the expanding nozzle of the turbine, the wheel of the latter being fitted either with double buckets of the Pelton type or single ones similar to the wheel of de Laval.

By the use of the vapor of water one of the most serious mechanical difficulties is overcome, the gases are cooled to a degree which prevents serious injury to the wheel. In one form of machine the hot gases, after having passed through the wheel, are directed over the tubes of a coil boiler, the steam from which is also discharged upon the turbine wheel through an independent nozzle. A 50 horse power machine of this type has been operated at Saint Denis with such success that an improved one of 200 horse power is being built.

M. Berthier refers to the theoretical analysis of gas-turbine cycles made by Mr. R. M. Neilson in a paper presented before the Institution of Mechanical Engineers about a year ago and reviewed in these columns in December, 1904, and cites the three essential points upon which further experience is required in order that a gas turbine may be scientifically designed. In the first place the losses occurring in the compression of the air to high pressures must be minimised. Rotary compressors are to be preferred, if such can be made of high efficiency, since one of the advantages sought to be realized by the use of the gas turbine is the replacement of reciprocating by rotary motion, and there would be small gain to secure rotating members for the power end if a reciprocating compressor is retained at the other end. We have already seen that Stolze employs a rotary compressor, and it is reported that the new Armengaud and Lemale turbine is to have a rotary compressor of the Rateau type, but details are lacking. Since the total efficiency of the machine depends very greatly upon the efficiency of the compression this is a most important element. Possibly the combination proposed by Mr. Neilson may be found experimentally desirable, this being to use an ordinary gas engine for the compression and preliminary combustion, employing the exhaust gases of the gas engine to drive a low-pressure gas turbine, much in the same manner as M. Rateau uses a low pressure steam turbine to utilize the exhaust from reciprocating high-pressure steam engines.

The second point demanding elucidation is that of the losses occurring in connection with the expansion of hot gases in divergent nozzles. This has already been treated in the leading pages of this Magazine in the issue for April, 1905, by Dr. Lucke, who has also discussed the question in the *Transactions of the American Society of Mechanical Engineers*, and it appears that there is room for a thorough experimental investigation of this important element in gas turbine design.

Mr. Neilson's third point is that of minimizing the losses by radiation and transference of heat from the gases to the metal at the high temperatures at which the parts must necessarily be operated.

In summing up, M. Berthier remarks that whatever the fluid employed, be it water, steam, or gas, the successful operation of impulse turbines depends upon the velocity of the fluid which acts upon the buckets of the wheel. In the cases under consideration this velocity is obtained by passing the fluid from a reservoir at a high pressure through a nozzle into a space at a lower pressure. Dr. Lucke has shown that there is a difference under these conditions, between gas and water; the volume of water is not changed, since it is practically incompressible, while the volume of a gas is increased in proportion as the pressure is lowered, according to the law of Mariotte.

We then have three principal cases:

First, that of non-compressible liquids, such as water. The velocity is that due to the drop in pressure, the density remaining constant.

Second, that of gases. The velocity is that due to the drop in pressure, at constant density, that is, without change of volume, or else it is due to the change of

density resulting from change of pressure and temperature.

Third, that of vapors. The velocity is due to the drop in pressure, at constant density; or else to the change in density consequent upon change in pressure, the vapor remaining in the state of vapor; or else to a change of state, caused by superheating or condensation, as the case may be.

Thus, according to the nature of the fluid employed, the velocity due to the pressure may have two sources; it may be mechanical or thermal in its origin. As Dr. Lucke indicates, the thermal increment of the velocity may be either positive or negative, and hence tend to augment or diminish the mechanical velocity. The final velocity, therefore, is not independent of the nature of the fluid used. Since the laws of discharge are not absolutely the same in all cases, it seems as if the form of the nozzle should be modified for the fluid.

The phenomena accompanying the expansion of gases behind a piston in a cylinder have been studied for a long time, but those accompanying free expansion are not so well known. Mr. Neilson urges the importance of experimental investigations in this respect, and the problem is one which may well occupy the attention of physicists.

The gas turbine question includes a number of unsolved problems; but, on the other hand, the available resources for their solution are numerous. It will permit the utilization of air and gas, air and hydrocarbons or alcohol, but also allow the combination of the explosion motor and the steam turbine using highly superheated steam in connection with flash boilers of the Serpollet type. The problem is before the physicist, the engineer, and the machinist, and it will require all their resources to effect a satisfactory solution.

THE PRODUCTION OF OXYGEN.

IMPROVED METHODS OF SEPARATING THE OXYGEN AND NITROGEN OF THE ATMOSPHERE BY THE RECTIFICATION OF LIQUID AIR.

Georges Claude—Comptes Rendus.

THE commercial applications of liquid air have proved to be but limited in number and value, although the liquid itself has proved most useful in laboratory investigations demanding the maintenance of low temperatures, as for example in connection with the study of the behaviour of steels under extreme cold, by the Alloys Research Committee, reviewed elsewhere in this issue. Another branch of research work, which may develop into commercial importance, is the production of pure oxygen by the separation of the elements of the atmosphere, this having been accomplished by several physicists, notably by M. Pictet, and by M. Claude. In recent papers presented before the French Academy of Sciences, and published in the *Comptes Rendus*, M. Claude describes the latest methods which have been devised for this purpose, which will be found of interest.

The early methods for separating the elements of the atmosphere, with especial intention of procuring pure oxygen, were based upon the fractional vaporization of liquid air, but these are now replaced by processes involving rectification. Liquid air, being composed of a mixture of two fluids, miscible in all proportions and of very different degrees of volatility, the possibilities of applying the principles of rectification to this mixture is evident. In fact, this application involves conditions practically identical with those employed for the rectification of mixtures of water and alcohol, with this advantage that the difference in volatility between liquid oxygen and nitrogen is much greater than between alcohol and water, so that the operation in this latter case is extremely effective. Thus alcohol boils at about 80° C., and water at 100° C., a difference of 20 degrees, while the boiling point of liquid oxygen is —181° C., and of nitrogen —194° C. This difference of 13 degrees, however, is much greater than really appears, for the importance of the degrees on the thermometric scale increases with great rapidity as the absolute zero is approached, and 13 degrees at the point of liquid air are equivalent to about 60 degrees at the tem-

perature of the boiling point of alcohol.

M. Claude describes first the method of rectification suggested by his assistant, M. Réné Lévy, this utilising the vaporisation of the liquid oxygen to furnish the cold to aid in liquefying air already compressed to 4 or 5 atmospheres. This system included the use of a rectifying tower, placed above the vaporiser, this utilising the counter-current principle to permit the ascending current of oxygen to be condensed by the descending liquefied air. In a modification of this apparatus M. Claude has succeeded in repeating the rectification effect in such a manner as to separate the oxygen wholly from the nitrogen, furnishing pure oxygen for scientific and commercial purposes, and consequently also delivering pure nitrogen, this being of great value for the manufacture of ammonia and the cyanides. In this system the cold produced by the evaporation is utilised for the production of a fresh quantity of liquid air, so that the method is brought within the commercial limitations of actual trade. The apparatus at present employed by the liquid air company, at Boulogne-sur-Seine, is capable of producing 1,000 cubic metres of oxygen, of 96 to 98 per cent. purity in twenty-four hours at a cost of one-twentieth that required for the electrolysis of water.

Among the practical difficulties which have been encountered in the perfection of the process that of the lubrication of the apparatus has not been the least. M. Claude describes the use which has been made of ether and petrol for lubricating purposes, but he has discarded both of these by using the liquid air itself as a lubricant, this simplifying the whole apparatus, and assuring a perfectly satisfactory operation.

The uses of pure oxygen and pure nitrogen in the arts have already been anticipated, and it is only the question of costs which are to be considered. M. Claude announces that he is about to place both of these products upon the market, and this being the case it should soon be possible to determine the extent to which such appliances as the oxy-hydrogen and oxy-acetylene blowpipes are to become tools within the reach of every machine shop. The manufacturing chemist will hail the supply of pure nitrogen as a welcome addition to his materials of production, and thus the much discussed value of liquid air in the arts will be determined, at least for the present. The electric furnace has placed the control of extremely high temperatures in the hands of the physicist and the engineer and the practical production of liquid air has given him command of the lower end of the temperature scale. The uses which he shall make of these resources depends wholly upon himself, and there is every evidence to show that he is not wasting his opportunities.

NICKEL ALLOY STEELS.

THE MECHANICAL, PHYSICAL, AND CHEMICAL PROPERTIES OF THE IRON-NICKEL-MANGANESE-CARBON ALLOYS.

Alloys Research Committee—Institution of Mechanical Engineers.

THE reports of the alloys research committee of the Institution of Mechanical Engineers have been welcomed by engineers and physicists as valuable contributions to our stock of knowledge of the materials of engineering. The seventh report, recently presented and discussed at meetings of the Institution, is devoted to the nickel-manganese alloys, this including certain iron-carbon alloys containing both nickel and manganese. The report bears the names of Dr. Carpenter, Mr. Hadfield and Mr. Longmuir, the actual research work having been performed at the National Physical Laboratory upon specimens furnished by Mr. Hadfield.

As the researches covered by the report were intended to determine the influence of the nickel content of such alloys it was decided to make the proportions of the other elements as nearly constant as possible. The base of the specimens was a Swedish charcoal iron of especial purity, this being melted with the ingredients nickel and Swedish white iron, the intention being to secure approximately uniform percentages of carbon and manganese, with percentages of nickel varying from zero to

20 per cent. According to the chemical analyses of the actual test pieces the carbon content varied from 0.40 to 0.52, it being intended to have a carbon of 0.45 per cent., while the proportion of manganese ranging from 0.79 to 1.03, this being a particularly difficult element to maintain at a constant proportion, owing to losses in melting. The material was cast into ingots, one-half of each ingot being forged down to a round bar, from which test pieces were taken; while the other half was machined into an additional set of test pieces, both annealed and unannealed.

The influence of nickel upon steel is generally regarded as tending to raise the elastic limit and the ultimate stress without seriously impairing the ductility, these properties, as pointed out by M. Guillet, depending also upon the carbon content. Earlier experiments upon nickel-manganese steels in which the carbon content was only about 0.17 per cent. have demonstrated the existence of a brittle zone, the members of which possessed a high tensile strength and low ductility, while above and below this zone the alloys were comparatively ductile.

The tests conducted by the present investigators were made on specimens normalised by heating to a temperature of 800° C., this temperature being found to clear safely the critical ranges of all the alloys under consideration; the annealing being done in a muffle and the temperature taken by a thermo-couple. The annealed test pieces were subjected to bending, tensile, torsion, and compression tests, the results being fully tabulated in the report and also plotted in curves. Impact tests and tests for hardness were also made and specimens were subjected to tensile tests at the temperature of liquid air, in order to furnish a continuation of the previous researches of Mr. Hadfield in this direction.

The general results of the mechanical tests may be summarized as follows:

"With the increase in nickel content up to 4 per cent., the change in properties is gradual; the material, when under elastic stress yields more to the stress; at the same time, after the apparent yield point is passed the maximum stress increases. Although the change in properties is gradual there is in nearly every case a more or less pronounced kick in the curves between 0 and 4 per cent. nickel. At some point between the percentages of 4.25 and 4.95 nickel there is a very sudden change in nearly all of the properties, evidenced by a rapid increase of maximum stress, which reaches the highest value at 6.42 nickel, a fall of ductility, and an increase of brittleness as shown by the bending, tension, torsion, and shock tests. Thus, as far as industrial products are concerned, a danger limit for nickel content is found at 4.25 per cent., when carbon and manganese are present to the extent of 0.44 per cent. and 0.88 per cent. respectively.

"After this sudden break in the curve the various properties alter more slowly again until a percentage somewhere in the neighborhood of 16 is reached, i. e., the brittle zone extends from about 5 to 16 per cent. From this point on the change is more rapid and in the reverse direction to the original rapid change."

The tests of the cast material gave results following generally the same order as those of the forged material, the maximum tensile strength being represented at a content of 7.95 per cent. nickel. Singularly enough this maximum is associated with an elongation of 4.5 per cent., and the three steels which in the forged condition are distinctly brittle, show in the cast normalized state elongations of 6.2 per cent., 4.5 per cent., and 6.2 per cent. These remarkable and unusual results find some analogies in other alloys. Thus the alloy containing 9.51 per cent. nickel, and 0.18 carbon, when subjected to the bending test, in the forged state, fractures at an angle of 5 degrees, while the same steel in the cast annealed state bends to an angle of 8 degrees. Similar results were obtained with an alloy containing 11.39 per cent. of nickel and 0.18 carbon, this steel, in bending, reaching an angle of 9 degrees when tested in the cast condition, while in the forged state fracture occurs at 3 degrees. The last two cases are taken from Mr. Hadfield's previous researches upon low carbon nickel-manganese steels.

The tests conducted at the temperature of liquid air show that these alloys are well adapted to be used at low temperatures. In every case there is an increase in tenacity at the low temperature over that at ordi-

nary temperatures. A remarkable increase is shown by the alloy containing 20 per cent. of nickel. At ordinary temperatures this steel shows a tensile strength of 43.9 tons per square inch, while at the temperature of liquid air, —182° C., the resistance rises to the remarkable figure of 157.2 tons, with an elongation of 15.5 per cent.

This 20 per cent. alloy is a remarkable one in various ways, having a very high degree of ductility, giving an elongation, at atmospheric temperature, of 55 per cent., and a reduction of area of 63.11 per cent., an ultimate strength of 43.9 tons, and a yield point of 15.33 tons.

The physical, chemical, and metallographical properties of the alloys tested are discussed at length in the report, including resistivity, permeability, specific gravity dilatation, and corrodibility, and there are also tables and diagrams of the critical ranges on heating and cooling. A very complete series of micro-photographs of the special alloys are shown in the illustrations to the report, these accompanying a discussion of the metallography of the alloys.

Taken as a whole this seventh report of the Alloys Research Committee is a worthy companion to its predecessors, and as a record of scientific research and a source of practical information it is to be commended.

ENGINEERING IN 1905.

A REVIEW AND RETROSPECT OF THE WORK IN VARIOUS DEPARTMENTS OF ENGINEERING DURING THE PAST YEAR.

The Engineer

IT has been the custom of our valued contemporary, *The Engineer*, to prepare each year a comprehensive review and retrospect of the progress of the past year in the principal departments of engineering, and such studies are always of value, both for their historical interest and for their service in future conduct of affairs. While this review is naturally prepared from the British viewpoint the engineering interests of Great Britain are so extensive that the progress of the art of the engineer in all parts of the world is necessarily included, and an excellent international and cosmopolitan review is thus found.

Broadly the year 1905 was a record one in several departments of industry. The coal output of the world, rightly regarded as a gauge of the manufacturing industries, was the heaviest ever known. In Great Britain the shipbuilding industry beat its previous records, while in the United States, as we have noted elsewhere, the production of iron again passed the maximum of previous years. The motor-car industry continues to grow, and the electrical manufacturing establishments maintain their activity. In Europe political uncertainties have done much to cause certain departments of trade to be held in suspense, notably in connection with the affairs of the Russian Empire, while the conclusion of peace in the Far East will naturally be followed by rapid internal industrial developments in Japan.

Taking up the various departments of engineering, it appears that there have been no great developments in mechanical engineering, the time having rather been one of steady development than of origination. Railways are increasing the weight of rails and the power and speed of locomotives, and the capacity and materials of cars have alike been improved, steel cars coming in for favorable consideration for both freight and passenger service. In marine engineering the turbine has extended its scope, the Carmania, with 20,000 horse-power, having been put into service, while work on the 70,000 horse-power machines for the new Cunard liners is progressing.

In reciprocating-engine design the principal new feature appears to be the drop-piston valve. Late tests have shown that a portion of the loss usually attributed to cylinder condensation may be due to leakages almost impossible of prevention with flat slide valves. By the employment of the drop piston valve, and the use of superheated steam, the steam consumption has been lowered to 8.6 pound per horse-power per hour. In connection with the use of superheated steam it has been shown that it is difficult to carry it in pipes for even a

moderate distance without loss, and hence the engine should be placed as close to the boilers as practicable. In Germany the best results have been secured with semi-portable engines, the engine being placed on the top of the boiler, and the highly superheated steam conducted directly to the engine without exposed piping.

The conspicuous development of the year has been in the department of internal-combustion engines. There has been no notable improvement in the engine itself, but the rapid progress which has been made in the introduction of the suction gas-producer system is responsible for much increase in business. Thermal efficiencies of 24 per cent., and commercial economies represented by costs of only one-twentieth of a penny per horse-power per hour, show what has been accomplished, while manufacturers both in Europe and America are busy with orders. The large gas engine has taken its place as an acceptable article of manufacture, and is now wholly out of the experimental stage. The gas turbine remains an object of interest and curiosity. Such few machines as have been made remain in the privacy of the experimental testing laboratories of their makers, and theoretical discussions, such as that appearing in this Magazine, in April of last year, from the pen of Dr. Lucke, have been studied only to confirm the opinion that no higher economy is to be expected than with the reciprocating type of machine. If the turbine is to become an effective form of the combustion motor it will probably because of its mechanical advantage rather than its possible thermal efficiency.

The automobile business is gradually emerging from the domain of sporting appliances into that of solid commercial manufacture. In certain directions the craze for high-powered high-speed cars continues, but the later trials which have attracted interest have been in connection with endurance and commercial efficiency. The motor omnibus is demanded, and the demand is gradually being supplied, while delivery wagons, and moderate-powered family and professional vehicles are beginning to receive the attention which they should have had long ago. The motor boat is in a similar stage of development, but is yet mainly in the sporting stage, although a number of useful applications have already been made in connection with the provision of auxiliary power for fishing vessels and motive power for naval launches.

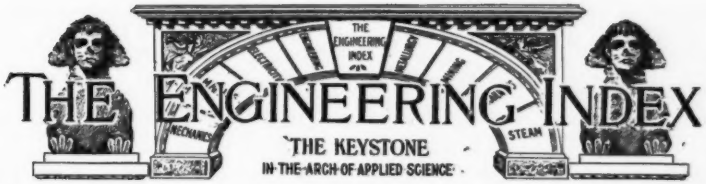
Machine tools are in a state of transition. The advent of high-speed steels has created a demand for machines capable of operating to advantage under the new cutting speeds and feeds, but this demand is not to be met by tools which are merely larger, heavier, and more highly powered than to older ones. Many manufacturers have preferred to strengthen their old tools and await the arrival of machines of entirely new design, and until such are forthcoming this industry cannot be expected to keep pace with its changed conditions.

Civil engineering enterprises in 1905 include great irrigation works, both in the United States and in India, while new bridges, both of stone and masonry, continue to be built. The masonry arch still maintains its supremacy for situations where its construction is practicable, while cantilever and braced-arch bridges hold the preference for structures of steel.

The growth of municipalities is accompanied by increased demands for better water supply, improved sewage and refuse disposal systems, and greater transport facilities. In London the electrification of the underground railway is a matter for comment, while in New York the year-old subway is already strained to its maximum carrying capacity. The water supply of Paris is demanding extension and improvement, while a long list of cities in various parts of the world gives indication of the extent to which the demand for better water supply exists.

Early in the year the headings of the Simplon tunnel met, and confirmed the accuracy of the surveys, and by May of the present year the new passage through the Alps is expected to be opened for traffic.

Altogether there has been a great mass of most excellent engineering work completed in 1905, while the new works projected and under way may be credited partly to the year which is past and partly to that which is now fairly begun. In all that has been undertaken the engineer has fully maintained his position as the man who directs the great forces in Nature to the use and convenience of man.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering	765	Mechanical Engineering	779
Electrical Engineering	771	Mining and Metallurgy	788
Industrial Economy	776	Railway Engineering	793
Marine and Naval Engineering	777	Street and Electric Railways	797

CIVIL ENGINEERING

BRIDGES.

Arches.

The New Steel Arch Street Bridge Across the Potomac River, Washington, D. C. Illustrated detailed description of an interesting bridge under construction, at a cost of $375,000. 2000 w. Eng News—Dec. 21, 1905. No. 73979.

The Plano Arch. John P. Hazen Perry. Illustrated description of the construction of this bridge on the C. B. & Q. R. R., in Illinois. A concrete arch of 75 ft. clear span with wing walls giving a total length of 210 feet. 3000 w. Harvard Engng Jour—Nov., 1905. No. 73742 D.

The Pont de Commerce at Liége (Le Pont de Commerce à Liége). Th. Seyrig. The bridge consists of twin steel voussoir arches, the thrusts at the middle pier balancing each other, leaving only a vertical component. 8000 w. 2 plates.

We supply copies of these articles. See page 799.

Mem Soc Ing Civ de France—Oct., 1905. No. 73882 G.

Denver.

Lawrence Street Bridge, Denver. Illustrated description of a highway bridge 74 feet wide and 156 ft. long, consisting of two plate girder spans skewed 42 degrees 10 minutes with their abutments. 1000 w. Eng Rec—Dec. 2, 1905. No. 73575.

Drawbridge.

A Temporary Bridge with Pontoon Draw Span Over the Chicago River. Illustrates and describes an interesting temporary structure near 22nd St., Chicago. It is a pile trestle with a swing span having one end supported by pivot on the fixed work, and the other end supported by a fixed bearing when closed and by a pontoon when swinging. 900 w. Eng News—Dec. 28, 1905. No. 74034.

Trunnion Bridge for W. & L. E. R. R. at Cleveland. A fully illustrated description of an improved type of lift drawbridge, with trunnion supports and counterbalanced leaves—replacing an old swing railroad bridge over the Cuyahoga river. 2500 w. Ry & Engng Rev—Dec. 16, 1905. No. 73783.

Girder Bearings.

Standard Bearings for Long-Span Plate Girder Bridges, Chicago, Milwaukee & St. Paul Ry. Illustrates and describes the character of the end bearings used. 1200 w. Eng Rec—Dec. 9, 1905. No. 73676.

New York.

Terminals of the Manhattan Bridge. Outlines the general design of the bridge and illustrates both terminals. 600 w. R R Gaz—Vol. XXXIX., No. 22. No. 73544.

The Upper Sections of the Manhattan Bridge Towers. Illustrates and describes details of towers, the scheme of horizontal bracing, &c., of the Manhattan bridge in New York City. 1000 w. Eng Rec—Dec. 2, 1905. No. 73571.

Paris.

The Austerlitz Bridge Across the Seine for the Metropolitan Railway of Paris. Réné Bonnin. States the conditions to be met and gives an illustrated description of the plan adopted, and method of erection. 4000 w. Eng News—Dec. 7, 1905. No. 73627.

Trusses.

The Theory of the Longitudinal Connections of Iron Bridge Trusses (Zur Theorie der Längsverbände Eiserner Fachwerkbrücken). Dr. Alexander Coulmas. A mathematical examination of the action of the various forces on longitudinal connections for different loadings. 7500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 2, 1905. No. 73873 D.

CONSTRUCTION.

Cement Blocks.

Decorative Forms in Cement Block Construction. Louis H. Gibson. Gives suggestions for the artistic use of this material, recently coming into use. Ills. 2500 w. Munic Engng—Dec., 1905. No. 73755 C.

Chimneys.

Statical Computations for Chimneys (Zur Statischen Untersuchung von Schornsteinen). Franz Heckelbacher. A brief examination of the conditions of stability for masonry chimneys of round and square section; with a graphical diagram enabling the proportions to be scaled off directly. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 25, 1905. No. 73872 D.

The Photobiography of a Chimney. Edgar Mels. Illustrated description of the second largest chimney in America, built at Newark, N. J. 800 w. Sci Am —Dec. 2, 1905. No. 73554.

Concrete.

Hair Cracks, Crazing and Map Cracks on Concrete Surfaces. Albert Moyer. Gives results of investigations made to determine the cause and the remedy. 1500 w. Eng Rec—Dec. 16, 1905. No. 73920.

Reducing the Voids in Broken Stone for Concrete by Mixing Different Sizes. E. J. McCaustland. Gives results of tests on mixtures of stones of various sizes. 700 w. Eng News—Dec. 7, 1905. No. 73626.

The Decoration of Concrete with Colored Clays. Henry C. Mercer. Read before the Assn. of Am. Port. Cem. Mfrs. Suggestions for the artistic treatment of concrete, with editorial. 2500 w. Eng News—Dec. 28, 1905. No. 74032.

Concrete Blocks.

The Waterproofing of Concrete Blocks and Walls. H. H. Rice. Discusses the causes of permeability and the remedies. Ills. 1500 w. Cement Age—Dec., 1905. No. 73711.

Dams.

Notes on Stresses in Masonry Dams. Max am Ende. A study of the distribution of compression and shearing stresses, deriving formulas for tracing the trajectories of the maximum tensile, compression, and shearing stresses in a masonry dam. 2800 w. Engng—Dec. 8, 1905. No. 73904 A.

The Changes at the New Croton Dam. Charles S. Gowen. An expression of the writer's views in regard to the necessity of removing the embankment section, at the south and replacing with an extension

of the masonry section. Does not think the rock foundation of the core-wall was unsafe. Ills. 3500 w. Pro Am Soc of Civ Engrs—Dec., 1905. No. 74093 E.

The Roosevelt Irrigation Dam in Arizona. Information concerning this extensive engineering work, with illustrations showing the substantial character of the concrete work. 1000 w. Sci Am—Dec. 16, 1905. No. 73724.

Erection.

American Methods of Erecting Buildings. R. A. Denell. Considers constructive methods, especially in regard to the increase in rapidity of construction and economy. Ills. Discussion. 12000 w. Jour Roy Inst of Brit Archts—Nov. 25, 1905. No. 74037 D.

Fireproof.

A $3,000 Fireproof House. F. W. Fitzpatrick. Illustrates and describes pleasing dwellings of hollow tile fireproof construction. 2200 w. Ins Engng—Dec., 1905. No. 74068 C.

The Majestic Building. Illustrated description of a fireproof combination theater and office building in Chicago. 1800 w. Ins Engng—Dec., 1905. No. 74069 C.

Fire Protection.

Fire Protection Precautions at the Stuyvesant Docks. H. W. Parkhurst. An illustrated article explaining the changes that have been made and their object, in these terminal facilities of the Illinois Central at New Orleans. 3500 w. R R Gaz—Vol. XXXIX., No. 25. No. 74012.

The Safeguarding of Life in Theaters, A Study from the Standpoint of an Engineer. John R. Freeman. Presidential address before the A. S. M. E. A statement of present conditions, the problem presented and the solution, with a discussion of the subject generally. Also editorial. 15500 w. Ills. Eng News—Dec. 14, 1905. No. 73732.

Moving Buildings.

Moving a Block of City Residences. Describes the removal of two rows of city residences in Brooklyn, N. Y., of brick and stone construction of different styles, built at different periods. Ills. 1200 w. Eng Rec—Dec. 16, 1905. No. 73922.

Piles.

Improved System of Concrete Piling. The report of the Committee on Science and the Arts on the invention of Frank Shuman. 700 w. Ills. Jour Fr Inst—Dec., 1905. No. 73935 D.

Reinforced Concrete Pile Foundations for the Lattemann Building, Brooklyn, N. Y. Illustrates and describes the largest foundation work with reinforced concrete piles yet carried out in the United States. 1200 w. Eng News—Dec. 7, 1905. No. 73624.

The Simplex System of Concrete Piling. Constantine Shuman. An illustrated detailed description of this method of constructing foundations, the apparatus used and the process of producing a concrete pile. Also reviews the development, the uses, &c., and gives a general discussion. 7000 w. Pro Engrs' Club of Phila—Oct., 1905. No. 73937 D.

Reinforced Concrete.

Reinforced Concrete and Tile Construction in an Atlantic City Hotel. Illustrated detailed description of the construction of the annex of the Hotel Marlborough, built entirely of hollow tiles, combined with reinforced concrete and terra cotta, without any structural steel, brick or timber work. 3000 w. Eng Rec—Dec. 23, 1905. Serial. 1st part. No. 74018.

The Computations for T-shaped Floor Beams of Reinforced Concrete (Beitrag zur Berechnung der Plattenbalken von T-förmigen Querschnitte aus Eisenbeton). G. Ramisch. Deriving formulas for beams of T section, reinforced with round rods near the lower edge. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 17, 1905. No. 73821 D.

The Construction of a Reinforced Concrete Power House. Brief illustrated description of a building just completed for the Baltimore Electric Power Company. 1000 w. Sci Am Sup—Dec. 9, 1905. No. 73636.

The Economical Design of Reinforced Concrete Floor Systems for Fire-Resisting Structures. John S. Sewell. Aims to present simple and accurate formulas, with methods of applying them, to designs of mimimum cost, and to show the value of certain little used features of design, from a fire-resisting and economical point of view. 10400 w. Pro Am Soc of Civ Engrs—Dec., 1905. No. 74095 E.

See also Civil Engineering, Materials.

Roads.

Construction of the Benguet Road, Luzon, Philippine Islands. Illustrates and describes a notable piece of highway construction through rough country, and under exceptionally hard conditions. 2500 w. Eng Rec—Dec. 23, 1905. No. 74015.

Roofs.

Notes on the Concert Hall at Zürich (A Propos de la Halle des Concerts de Zurich). Prof. B. Recordon. Discussing especially the design of framed timber roofs of large span; the Zurich concert hall is covered by a braced arch of 50 metres clear span. 3500 w. 1 plate. Bull Tech de la Suisse Rom—Nov. 10, 1905. No. 73877 D.

We supply copies of these articles. See page 799.

The Catastrophe at Charing Cross. Editorial on the accident at Charing Cross Station, when two bays of the large roof collapsed without any apparent reason. 1200 w. Engng—Dec. 8, 1905. No. 73907 A.

Steelwork.

Steelwork of the Ash Plant of the New York Edison Co. Illustrated detailed description of this plant in New York, which contains 350 tons of structural steel. 1800 w. Eng Rec—Dec. 9, 1905. No. 73674.

Subways.

Mail Handling Facilities of the Chicago Freight Tunnels. Illustrates and describes the arrangements made, especially the construction of a tunnel to run under the post-office where the mails may be loaded and unloaded. 1000 w. R R Gaz —Vol. XXXIX., No. 25. No. 74014.

Rapid Transit Subway Construction on Fulton St., Brooklyn. An account of the change in plans to a four-track structure, with illustrated description of construction work. 2300 w. Eng Rec—Dec. 23, 1905. Serial. 1st part. No. 74016.

Tunnels.

Progress in the New Jersey Tunnels and Subways. Information concerning the tunnels connecting Jersey City and New York. Ills. 1500 w. Sci Am—Dec. 9, 1905. No. 73632.

The Crowning Work of the Simplon Tunnel. Drawings and engravings showing the means employed for the very difficult operation of constructing the passage through 40 m. of saturated decomposed clay slate. 1600 w. Engr, Lond—Dec. 8, 1905. No. 73911 A.

The Hudson River Tunnels. Brief accounts of three pairs of tunnels being extended under the Hudson River between New York and Jersey City. 1700 w. Ir Age—Dec. 7, 1905. No. 73580.

Tunnel Construction on Salt River Reclamation Project, Arizona. Beverly R. Harrison. Briefly describes some difficult tunnel work. Ills. 1200 w. Eng Rec—Dec. 16, 1905. No. 73919.

MATERIALS OF CONSTRUCTION.

Building Stone.

The Microscopic Structure of Building Stones. Henry Leffmann. Discusses the rocks and rock-substitutes used in engineering construction, and the relation between laboratory observation and practical application, indicating results that have been obtained. Also general discussion. 7000 w. Pro Engrs' Club of Phila —Oct., 1905. No. 73936 D.

Cement.

Experiments on the Manufacture of White Portland Cement. Charles Delavan Quick. Discusses the commercial practicability of producing a pure white Portland cement. 1800 w. Eng News—Dec. 28, 1905. No. 74033.

Portland Cement Materials. O. H. Howarth. Considers the importance of thorough mixing; the presence of iron; and the sources of materials in the United States. 4800 w. Mines & Min—Dec., 1905. No. 73716 C.

The First Attempt to Manufacture Natural Cement in the United States. Edwin C. Eckel. Gives a letter describing an attempt to manufacture this product, made by a Mr. Randolph, of Virginia, in 1817. 1000 w. Eng News—Dec. 7, 1905. No. 73630.

Explosives.

The Chemical Analysis of Dynamites. Graduation thesis by J. P. Benbrook, Jr., and J. H. Fulton. Introductory notes explaining the composition of modern explosives, especially dynamites, giving two methods of analysis. 2700 w. Stevens Ind—Oct., 1905. No. 73930 D.

The Testing of Explosives Used in Engineering. J. B. Porter. Illustrates and describes apparatus and methods used discussing especially closed explosion chambers, crusher gauges, and devices for miniature blasts, reporting recent tests. Ills. 2400 w. Can Soc of Civ Engrs—Nov. 30, 1905. (Ad. proof.) No. 74092 C.

Reinforced Concrete.

The Bursting Strength of Reinforced Concrete Pipes. Describes experiments made by the engineers of the U. S. Reclamation Service with great care, which indicated that such a system of construction is not satisfactory for pipes under considerable heads. Also editorial. 5500 w. Eng Rec—Dec. 9, 1905. No. 73675.

The Fire-Resisting Qualities of Reinforced Concrete. Capt. John Stephen Sewell. An engineer's views on the requirements of fireproof construction and the adaptability of reinforced concrete. Ills. 4000 w. Ins Engng—Dec., 1905. No. 74067 C.

See also Civil Engineering, Construction.

Steelwork.

Structural Steelwork. W. S. Smart. Abstract of a paper before the Midland Jun. Gas Engng. Assn. Discusses the materials, girders, roofs and roof-covering, columns, &c. 3500 w. Ir & Coal Trds Rev—Dec. 1, 1905. No. 73687 A.

MEASUREMENT.

Geodesy.

The Complementary Geodetic Triangulation of the Higher French Alps (Sur les Triangulations Géodesiques Complémentaires des Hautes Regions des Alpes Françaises). P. Helbronner. With a list

of stations and altitudes, and a brief review of the field work. 1800 w. Comptes Rendus—Nov. 13, 1905. No. 73826 D.

Photogrammetry.

The Photographic Measurement of Ocean Waves (Photographische Messung der Meereswellen). W. Laas. A fully illustrated description of the application of methods of photographic surveying to the measurement of sea waves, during a voyage to and from South America. Three articles. 8000 w. 3 plates. Zeitschr d Ver Deutscher Ing—Nov. 25, Dec. 2, 9, 1905. No. 73802 each D.

Prismoidal Formula.

A New Form of Procedure for Earth-Work Computations and a Slide Rule Therefor. C. W. Crockett. Explains the use of the prismoidal formula and the cases to which it is applicable, indicating the process that led to the general rule, and the circular slide rule prepared by the writer. 2800 w. Eng News—Dec. 21, 1805. No. 73978.

Surveying.

Corrections for Instrumental Errors in Topographical Surveying (Compensation des Erreurs Instrumentales dans les Opérations Topographiques). H. Naudin. A review of the various errors of theodolites, levels, and other geodetic instruments, with methods for calibration and correction. 5000 w. Revue Technique—Nov. 25, 1905. No. 73839 D.

Mineral Land Surveying. James Underhill. Presents methods used at the present time for the survey of mineral lands in the western part of the United States. 1700 w. Min Rept—Dec. 7, 1905. Serial. 1st part. No. 73662.

Note on a New Instrument for Surveying Deep Bore Holes. J. B. Porter. Briefly outlines the usual methods of surveying bore holes, and gives a description of an apparatus invented by Wm. Helme, of Johannesburg. 1500 w. Ills. Can Soc of Civ Engrs—Nov. 30, 1905. (Adv. proof.) No. 74090 C.

Surveys for New York State Road Improvements. C. W. Trumbull. Read at Cornell Univ. An account of the methods of carrying out the necessary preliminary work for the extensive improvement of public highways now in progress. 5500 w. Eng Rec—Dec. 9, 1905. No. 73672.

Theodolite.

Some Surveying Instruments. An illustrated description of a special theodolite, made by Mr. Coradi, of Zürich, and a tacheometer, invented by Herrn. Mayer, and Wiesmann, engineers on the Simplon Tunnel. 1700 w. Engr, Lond—Dec. 15, 1905. No. 74057 A.

Transit.

Specifications for an Engineer's Transit and Level. L. S. Smith. A discussion of the best type of transit for topographic work, the changes needed, &c. Also engineer's leveling instruments. Ills. 4200 w. Wis Engr—Dec., 1905. No. 73750 D.

Triangulation.

The Triangulation and Construction Survey for the Simplon Tunnel. Horace Andrews. A summary of the work involved in the triangulation and the construction-surveys. 3000 w. Eng News—Dec. 21, 1905. No. 73982.

Wind Pressure.

A Recording Device for Measuring Wind Pressure (Registrierender Winddruck-Messapparat). Rudolf Müller. The direct pressure exerted on a square plate is transmitted to a recording drum; the force being opposed by a counterweight. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 9, 1905. No. 73874 D.

MUNICIPAL.

Asphalt Plant.

An Asphalt Plant for Walks and Crossings in Small Cities. H. B. R. Craig. Describes an asphalt plant operated by the city of Kingston, Ont., for the past twelve years. 1000 w. Can Soc of Civ Engrs—Dec. 14, 1905. (Adv. proof.) No. 74088 C.

Destructors.

Destructors and Their Bye-Products. F. L. Watson. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Describes the means of feeding in use, systems of storing, the methods of taking of the gases of combustion, &c., and matters relating to the plant generally. 4000 w. Elect'n, Lond—Dec. 1, 1905. No. 73683 A.

Pavements.

Brick Paving. Discusses present day methods and the details that will insure good construction, materials, &c. 3000 w. Munic Jour & Engr—Dec., 1905. No. 73514 C.

Brick vs. Asphalt Pavements. An illustrated article showing cost of construction and repairs of the rival pavements in Syracuse, N. Y. 1000 w. Brick—Dec., 1905. No. 73579.

Sewage.

Sewage Disposal at Berlin, Ont. A sewage plant, comprising two septic tanks, two storage tanks, a pumping station, and 14 acres of intermittent sand filters, is illustrated and described. 2400 w. Eng Rec—Dec. 23, 1905. No. 74017.

Sewage Disposal for Mansions and Large Country Houses. A. S. Goodridge. Read before the Inst. of San. Engrs. Considers methods of disposal, advocating the natural or earth processes wherever it is

possible to apply them. 4000 w. Dom Engng—Dec. 9, 1905. No. 73649.

The Bacterial Purification of Sewage. Albert Glyndon. Gives a brief description of the more important systems of sewage disposal now in use. Ills. 2500 w. Sci Am—Dec. 9, 1905. No. 73631.

Sewers.

American Sewer Design and Construction. John S. Hodgson. With special reference to the metropolitan main drainage works, of Boston, Mass. 7500 w. Munic Jour & Engr—Dec., 1905. No. 73513 C.

Difficult Sewer Construction in Minneapolis. Illustrations, and brief description of sewers of concrete construction laid through land which was formerly the bed of the Mississippi River, and later a public dump ground. 600 w. Eng Rec—Dec. 2, 1905. No. 73576.

Joint Trunk Sewer of Eleven New Jersey Municipalities. Gives statistics of construction and illustrated description of notable details of this great work. 1800 w. Munic Engng—Dec., 1905. No. 73756 C.

Sewer Construction in Brooklyn. Explains the complications that have made necessary a number of large relief sewers, and much reconstruction of the existing sewers. 1700 w. Ills. Eng Rec—Dec. 2, 1905. No. 73573.

WATER SUPPLY.

Amsterdam.

Notes on the Improved Water Supply Works for the Amsterdam District (Mededeeling betreffende de Werken ten Behoeve van de Drinkwatervoorziening in de Stelling van Amsterdam). R. P. van Royen. Describing the complete plant for a filtered supply of ground water. 15000 w. De Ingenieur—Nov. 11, 1905. No. 73880 D.

Filters.

The Reconstruction of the Poughkeepsie Water Filters. This was the first sand filter built in the United States. It has been completely reconstructed and covered and its new features are illustrated and described. 2800 w. Eng Rec—Dec. 2, 1905. No. 73569.

Reservoirs.

The Construction of a Reinforced Concrete Reservoir at Fort Meade, South Dakota. Samuel H. Lea. Gives a brief description of the locality, and the conditions requiring the construction, and the new pipe line, with details of the reservoir and its construction. Ills. 7400 w. Eng News—Dec. 28, 1905. No. 74031.

Springs.

Causes of the Diminution in the Flow of Springs (La Cause de l'Appauvrissement des Sources). M. Houllier. A review of observations made in the valley of the Somme, showing that intensive cultivation of the soil is abstracting an increasing proportion of moisture. 2500 w. Revue Technique—Nov. 25, 1905. No. 73840 D.

Treatment.

The Treatment of Water with Copper Sulphate at Denver, Colo. George T. Prince. Gives results of the treatment of a small lake at City Park, and also the treatment of Marston Lake reservoir. Ills. 500 w. Eng News—Nov. 30, 1905. No. 73550.

Wells.

Water Supply and the Driving of Wells. John Sanford. An illustrated article on this work in connection with the development of farm plumbing work. 3500 w. Met Work—Dec. 30, 1905. No. 74086.

WATERWAYS AND HARBORS.

Erosion.

The Coast Erosion and Sea Defences of North-Western Europe. Abstract of three articles by M. Bonnin, in *La Nature*, supplemented by observations. 1600 w. Engr, Lond—Dec. 1, 1905. No. 73696 A.

Locks.

Mechanical Lift Locks in America. Lieut-Col. Thomas W. Symons. Extracts from a paper submitted to the 10th Int. Nav. Cong. Describes the three kinds of mechanical locks suggested to accomplish the lift of 112 ft. at Cohoes, and the rather remarkable lock proposed for Lockport. 2000 w. Eng Rec—Dec. 16, 1905. No. 73921.

Panama.

Mr. Wallace Before the Panama Board. A statement of the recommendations of the former Chief Engineer of the Isthmian Canal. 1700 w. R R Gaz—Vol. XXXIX., No. 22. No. 73543.

The Conflict of Engineers Over Plans for the Panama Canal. Three papers by Mr. William Ham. Hall discussing the relative merits of the several different plans for the canal and explaining some of the reasons for the conflict of opinion among engineers. 7000 w. Eng News—Nov. 30, 1905. Serial. 1st part. No. 73549.

Paris.

The Port of Paris (Le Port de Paris). Pierre Jolibois. A detailed account of the growth of the port and its successive improvements since the beginning of the nineteenth century. 10000 w. Revue Technique—Oct. 25, 1905. No. 73834 D.

Pier.

Pier in Reinforced Concrete on the Guadalquivir, Spain (Embarcadero de

Hormigon Armado en el Guadalquivir). Juan Manuel de Zafra. Illustrated description of a pier constructed on the Hennebique system, with double track, and unloading derrick. 2000 w. 3 plates. Revista de Obras Publicas—Nov. 15, 1905. No. 73869 D.

River Improvement.

The Grand River, Ontario Peninsula. W. H. Breithaupt. Discusses the effects of deforestation and swamp drainage, and the need of river improvement. Ills. 2000 w. Can Soc of Civ Engrs—Dec. 14, 1905. (Adv. proof.) No. 74089 C.

Suez Canal.

The Clearing of the Suez Canal from Obstruction by a Dynamite Ship (Déblaiement du Canal de Suez Obstrué par un Navire Chargé de Dynamite). An illustrated account of the clearing of the Suez Canal from the wreck of the dynamite steamship Chatham. 2000 w. Génie Civil—Nov. 18, 1905. No. 73809 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Space Telegraphy.

Recent Advances in Wireless Telegraphy. J. Erskine-Murray. Abstract of a paper before the Glasgow Sec. of the Inst. of Elec. Engrs. Explains the Marconi untuned coherer system, the modern tuned systems, the more recent systems, the transmitters, limit of distance, &c. 5800 w. Elect'n, Lond—Dec. 15, 1905. No. 74049 A.

The Murgas System of Wireless Telegraphy. Joseph Murgas. Illustrated description of this invention for transmitting intelligence. The main object is to produce different spark frequencies from a source of current without the employment of interrupters. 1500 w. Elec Rev, N Y—Dec. 2, 1905. No. 73511.

The Production of Mechanical Effects by the Electric Current at a Distance (Production à Distance des Effects Mécaniques du Courant Electrique sans Fil de Ligne). C. D. Kubitzki. An illustrated description of the apparatus of Branly for controlling distant electrical devices by magnetic waves. 2000 w. Revue Technique—Oct. 25, 1905. No. 73833 D.

Tele-Photography.

Long Distance Electric Photography (Elektrische Fernphotographie). Dr. Arthur Korn. A review of the methods which have been proposed for the transmission of portraits and autographs by electricity, with a special account of the recent successful operation between Munich and Nuremberg. 3500 w. Elektrotech Zeitschr—Dec. 14, 1905. No. 73859 B.

DISTRIBUTION.

Cables.

Street Cable Systems. S. J. Watson. Abstract of a paper read before the Manchester Loc. Sec. of the Inst. of Elec. Engrs. and of the discussion. Discusses the design and arrangement of both the draw-in systems and the solid systems, cost of construction, &c. 4800 w. Elect'n, Lond—Dec. 8, 1905. No. 73902 A.

Conductors.

An Improved System of Arranging Electrical Conductors (Eine Neue Verlegungsart für Leitungen). Ernst Kuhlo. Describing an improved form of metallic tube and connections for underground electric conductors. 2500 w. Elektrotech Zeitschr—Dec. 7, 1905. No. 73858 B.

Twin Flexibles. Donald Smeaton Monro. Notes on the uses and frailties of flexible cord conductors. 1700 w. Elec Rev, Lond—Nov. 24, 1905. No. 73594 A.

Converters.

"Permutators." Charles V. Drysdale. Describing a special form of rotary converter, in which the exciting field is produced by the primary current in a short-circuited magnetic core, instead of using an external magnet. 2300 w. Elect'n, Lond—Dec. 8, 1905. No. 73901 A.

Detectors.

Ground Detectors and Their Connections. James T. Coe. Describes various types, with diagrams. 2500 w. Am Elect'n—Dec., 1905. No. 73568.

Fuses.

Notes on the Standardization of Fuses. Alfred Schwartz. Considers the particulars in connection with which standardization would be advantageous. 2400 w. Elec Rev, Lond—Dec. 1, 1905. No. 73680 A.

Notes on Continental Systems of Fuse Standardization. Alfred Schwartz. Gives the principal points in connection with fuses contained in the official regulations, with remarks. 2000 w. Elec Rev, Lond—Dec. 15, 1905. No. 74046 A.

House Service.

Electricity as a Home Comfort. J. D. Mackenzie. Considers some of the applications and discusses the design and the method of executing the work. 3000 w. Elec Engr, Lond—Dec. 15, 1905. Serial 1st part. No. 74043 A.

We supply copies of these articles. See page 799.

Installation.

The Installation of Electric Equipment from a Fire Insurance Point of View. C. W. Rohrer. The proper installation, the testing of materials, and the hazards of defective wiring are discussed, and the importance of inspection. 1800 w. Cal Jour of Tech—Sept., 1905. No. 74078 C.

London.

London's Power Supply. T. H. Minshall. Information concerning the present supply of electrical energy, and the proposed schemes, the relative cost of production, &c. 1400 w. Elec Wld & Engr—Dec. 9, 1905. No. 73668.

Networks.

Computations for Equalization in Closed Networks (Die Ausgleichsrechnungen in Geschlossenen Leitungsnetzen). B. Soschinsky. A mathematical investigation based upon an improvement of the approximate method of Gauss. Two articles. 8000 w. Elektrotech Zeitschr—Nov. 23, 30, 1905. No. 73853 each B.

The Distribution of Pressure and Current Over Alternating-Current Circuits. A. E. Kennelly. Explains methods of computation. 3500 w. Harvard Engng Jour—Nov., 1905. Serial. 1st part. No. 73743 D.

Switches.

Improved Switch System for High Voltages in Mining Plants (Moderne Hochspannungs-Schaltanlagen für den Betrieb in Bergwerks-Anlagen). H. Mack. Especial attention is given to the prevention of ignition of mine gases; oil switches are described, and the general arrangement of underground installations. 1800 w. Elektrotech Zeitschr—Nov. 30, 1905. No. 73854 B.

Oil-Bath Switchgear. Leonard J. Pumphrey. Considers some of the points of a good oil for switch work. 1500 w. Elec Rev, Lond—Nov. 24, 1905. No. 73593 A.

ELECTRO-CHEMISTRY.

Accumulators.

A Novel Storage Battery. Dr. Alfred Gradenwitz. Describes a novel accumulator being brought out in Germany in which the two electrodes are made of lead and zinc peroxide. 1200 w. Am Elect'n—Dec., 1905. No. 73563.

Some Points Relating to Storage Batteries and Boosters. L. Brockman. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Discusses features of present-day cells, their function and management, and various types of boosters and the work for which each is suited. 7000 w. Elec Engr, Lond—Dec. 15, 1905. No. 74045 A.

The Chemical Composition of the Nickel Oxide Electrode in the Jungner-Edison Accumulator (Ueber die Chemische Zusammensetzung der Nickeloxyd-Elektrode im Jungner-Edison-Akkumulator). Julian Zedner. An examination of the chemical nature of the active material in the Edison storage battery. 2000 w. Zeitschr f Elektrochemie—Nov. 17, 1905. No. 73867 G.

The Edison Iron-Nickel Accumulator. M. U. Schoop. Translated from the *Elektrotechnische Zeitschrift*. An illustrated article giving data and test results of a cell experimented with by the writer. 7700 w. Sci Am Sup—Dec. 23, 1905. Serial. 1st part. No. 73989.

Electric Furnaces.

Electrically-Heated Carbon-Tube Furnaces. Abstract of a paper by R. S. Hutton and W. H. Patterson before the Faraday Soc. Deals with electric furnaces constructed with a carbon tube through which an electric current is passed. Ills. 1400 w. Elec-Chem & Met Ind—Dec., 1905. No. 73723 C.

Electrolysis.

The Theory of Electrolytic Dissociation (Versuch einer Theorie der Elektrolytischen Dissociation). R. Malmström. A mathematical examination of the theory of Jahn and Nernst upon the weakening of a strong electrolyte by dissociation taking into account the electrical energy of the ions. 5000 w. Zeitschrift f Elektrochemie—Nov. 17, 1905. No. 73866 G.

Hypochlorites.

Some Observations Respecting the Relation of Stability to Electro-Chemical Efficiency in Hypochlorite Production. W. Pollard Digby, before the Faraday Soc. Reports results of tests which show that no test of the efficiency of any apparatus for the electrolytic productions of the hypochlorites can be regarded as complete without an estimation of losses through instability, and a mention of the volume of the contents of the electrolyzing tank. 1800 w. Elec Engr, Lond—Nov. 24, 1905. No. 73591 A.

Review.

The Progress of Electrochemistry in the Past 25 Years (Progrès de l'Electrochimie dans ces Derniers 25 Ans). C. D. Koubitzki. A review of the results following the work of Arrhenius, and the development of the theory of ions. 3000 w. Revue Technique—Nov. 10, 1905. No. 73837 D.

ELECTRO-PHYSICS.

Commutation.

Commutation Theory. A. Press. Mathematical discussion leading to working rules for preventing sparking at brushes. 800 w. Elec Wld & Engr—Dec. 16, 1905. No. 73923.

We supply copies of these articles. See page 799.

Notes on Commutation and Pole-Changing (Einiges über Kommutation und Wendepole). E. Arnold. A review of the discussions of Müller and of Pichelmayer, deriving formulas for computing the effects of commutation. 3000 w. Zeitschr f Elektrotechnik—Nov. 26, 1905. No. 73862 B.

Condensers.

High Tension Electric Condensers (Les Condensateurs Electriques à Haute Tension). A. Schoenenberger. Describing the Moscicki condensers, made of glass tubes coated with electrically deposited silver. 2000 w. Bull Tech de la Suisse Rom—Nov. 10, 1905. No. 73878 D.

Definitions.

Voltage Voltage-Difference, Potential Potential-Difference, Electromotive Force (Spannung, Spannungsdifferenz, Potential, Potentialdifferenz, Elektromotorische Kraft). Fritz Emde. A mathematical examination of electric potential relations, deriving critical definitions in accordance with the notation of the vector analysis. 4000 w. Zeitschr f Elektrotechnik—Dec. 10, 1905. No. 73865 B.

Electromagnets.

Easy Method of Approximating Magnet Windings. Charles R. Underhill. Describes a graphic system, giving charts and citing actual cases to facilitate following the methods employed. 900 w. Am Elect'n—Dec., 1905. No. 73565.

Test of a Valve Magnet. C. P. Nachod. Gives a test on a magnet, showing the effect which the position of the magnetizing coil with respect to the working air-gap has on the pull produced. 400 w. Elec Wld & Engr—Dec. 23, 1905. No. 74029.

The Approximate Calculation of Plunger Electromagnets. Charles R. Underhill. Shows graphically the relation between pull, area, ampere-turns, and length of air-gap, or stroke of plunger, with mathematical explanation. 400 w. Elec Wld & Engr—Dec. 16, 1905. No. 73925.

Induction.

Standards of Mutual Induction. G. F. C. Searle, and J. R. Airey. Explains the method of calculating the coefficient of mutual induction to any desired degree of accuracy, when the secondary coil lies inside the primary coil. 3500 w. Elect'n, Lond—Dec. 8, 1905. No. 73903 A.

Interrupters.

A Study of Interrupters (Sur les Eclateurs). R. de Valbreuze. A general review of the development of modern interrupters, with especial reference to the production of Hertzian waves for space telegraphy. 10000 w. Bull Soc Int d Electriciens—Nov., 1905. No. 73868 F.

GENERATING STATIONS.

Accumulators.

See Electrical Engineering, Electrochemistry.

Alternators.

The Dick Kerr Alternator for Steam Turbine Drive. Illustrated description of a new alternator for steam-turbine speeds. 900 w. Elect'n, Lond—Nov. 24, 1905. No. 73595 A.

The Influence of Armature Reaction upon the Wave Form of Alternators (Der Einfluss der Ankerrückwirkung auf die Wellenform von Wechselstrommaschinen). Dr. G. Benischke. A study of the causes of variation of wave forms from the true sine curve. 3000 w. Zeitschr f Elektrotechnik—Nov. 19, 1905. No. 73861 B.

Armatures.

Finding Faults in a Direct Current Armature. Adolph Shane, in *The Iowa Engineer*. Explains methods of especial interest for small plants. 1000 w. Engr, U S A—Dec. 1, 1905. No. 73617 C.

Winding of Direct-Current Armatures. A. C. Jordan. A detailed description of the various operations performed by an armature winder. Ills. 2500 w. Elec Jour—Dec., 1905. No. 74074.

Berlin.

Machinery for the Extension of the Berlin Electricity Works (Maschinenanlagen zur Erweiterung der Berliner Elektrizitätswerke). Illustrating two new generating sets of 6,500 h. p. each, the triple-expansion engines by Sulzer and by the Görlitz works, with A. E. G. alternators. 1800 w. 3 plates. Zeitschr d Ver Deutscher Ing—Dec. 9, 1905. No. 73807 D.

Hydro-Electric.

Construction of Canadian Niagara Power Company's 100,000-Horse-Power Hydroelectric Plant at Niagara Falls, Ontario. Cecil B. Smith. Abstract of a paper read before the Canadian Soc. of Civ Engrs. Describes the construction work, buildings, machinery, &c. 5000 w. Elec Rev, N Y—Dec. 2, 1905. No. 73512.

Hydraulic Station at Cusset, near Lyons, France. F. M. Bryan. An illustrated description of one of the largest hydraulic plants in France, which utilizes the power of the Rhone for operating lamps and motors in the city of Lyons. 3000 w. Elec Wld & Engr—Dec. 9, 1905. No. 73665.

Hydro-Electric Development at Garvins Falls, Bow, N. H. Edward B. Richardson. A detailed description of the station equipment. The plant will have a total capacity of 3,950 kw. 2800 w. Jour Assn of Engng Socs—Oct., 1905. No. 73749 C.

We supply copies of these articles. See page 799.

Hydro-Electric Development in Italy. L. Ramakers. Illustrated detailed description of the 36,000 volt transmission plant at Montereale-Cellina. 2000 w. Am Elect'n—Dec., 1905. No. 73564.

Hydro-Electric Power Under the Highest Head in New England. Illustrated detailed description of the interesting plant of the Chittenden Power Co., near Rutland, Vt. 4000 w. Elec Wld & Engr—Dec. 2, 1905. No. 73612.

The Chatel St. Denis Station (Usine de Chatel-St.-Denis). K. A. Breuer. A fully illustrated description of one of the power houses of the Freybourg district in Switzerland. Serial. Part I. 2000 w. 1 plate. Bull Tech de la Suisse Rom—Nov. 25, 1905. No. 73879 D.

The Garvins Falls Dam, Canal and Hydro-Electric Plant, Bow, N. H. George G. Shedd. An illustrated description of the power development at this point on the Merrimac River, about four miles below Concord, N. H. 3500 w. Jour Assn of Engng Soc's—Oct., 1905. No. 73748 C.

The Hydraulic Works of the Chittenden Power Co., Rutland. An illustrated description of a plant which will furnish electricity for street railway, light and power purposes at Rutland, Vt. 3000 w. Eng Rec—Dec. 9, 1905. No. 73673.

The Hydro-Electric Power Plant of the Brembo River. Dr. Alfred Gradenwitz. Illustrates and describes this recently completed plant in northern Italy. 1200 w. Sci Am Sup—Dec. 30, 1905. No. 74062.

The Hydro-Electric Station at Champ. A. Steens. Illustrated description of a power plant built to furnish electricity for motive power in various industrial establishments in the vicinity of the Fure and Morge valleys. Contains an important reinforced-concrete conduit. 2000 w. Eng Rec—Dec. 9, 1905. No. 73671.

The Trinity River Plant of the North Mountain Power Company. Brief illustrated description of an interesting power transmission system of the Pacific Coast, and some of the difficulties of its construction. 1200 w. R R Gaz—Vol. XXXIX., No. 26. No. 74085.

Isolated Plant.

An Electric Power Plant in the West Indies. Percival Robert Moses. A general description of an isolated plant in a plantation, with tabulated records of performance, and details of operative costs. 3500 w. Engineering Magazine—Jan., 1906. No. 73896 B.

Power Plant of a Large Cotton Mill. W. H. Smead. Illustrates and describes an interesting electrical power plant at Charlotte, N. C., for operating cotton mills. 1300 w. Engr, U S A—Dec. 15, 1905. No. 73787 C.

The Mechanical Plant of the Tietz Warehouse in Munich (Die Technischen Einrichtungen des Warenhauses Hermann Tietz in München). Julius Weil. Describing the plant of a large department store. Four 200 h. p. Diesel motors are coupled direct to dynamos for power and lighting. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 25, 1905. No. 73803 D.

London.

A New Electric Power Scheme for London. Outlines the scheme of the Additional Electric Power Supply (London) Bill, discussing its main points. 3300 w. Engng—Nov. 24, 1905. No. 73603 A.

Bow Electric Generating Station. W. H. Patchell. Abstract of a paper read before the Inst. of Elec. Engrs. illustrating and describing the station and its equipment. 2500 w. Mech Engr—Dec. 16, 1905. Serial. 1st part. No. 74042 A.

New York.

The New Waterside Station of the New York Edison Company. Fully illustrated detailed description of this large station on the East river water-front, Manhattan, New York. 1300 w. Power—Dec., 1905. No. 73699 C.

Switzerland.

Electric Plant of the City of Thun, Switzerland. B. F. Hirschauer. Illustrates and describes this plant which is operated by hydraulic power, obtained from the river Aar. 2500 w. Elec Rev, N Y—Dec. 23, 1905. No. 73992.

See also Civil Engineering, Construction.

LIGHTING.

Balancers.

Regulation and Compounding of Lighting Balancers. Budd Frankenfield. Gives methods for determining the regulation or the compounding. 2800 w. Elec Wld & Engr—Dec. 23, 1905. No. 74026.

Churches.

The Lighting of Churches and Libraries. E. Leavenworth Elliott. Discusses the illumination of both gothic and churches of the amphitheater type and of libraries, giving suggestions. Ills. 2500 w. Cent Sta—Dec., 1905. No. 73655.

Streets.

Street Lighting. Haydn T. Harrison. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the factors of importance in judging the degree of illumination in streets, and the means of comparing accurately, based on the measurement of the minimum illumination. 3300 w. Elect'n, Lond—Dec. 15, 1905. Serial. 1st part. No. 74048 A.

Strong Currents.

A Method for Measuring Heavy Currents (Strommesser für Hohe Stromstärken). Dr. Eugen Nesper. The current is measured by the manner in which it affects iron filings in proximity to a permanent magnet. 1200 w. Elektrotech Zeitschr—Nov. 30, 1905. No. 73855 B.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

MEASUREMENT.

High Frequency.

The Measurement of High-Frequency Currents and Electric Waves. Abstract of a Cantor lecture by Prof. J. A. Fleming on recent progress in quantitative measurements. Ills. 3500 w. Engng—Dec. 1, 1905. No. 73690 A.

Losses.

The Measurement of Iron Losses in Asynchronous Polyphase Motors (Messung und Berechnung der Eisenverluste in den Asynchronen Drehstrommotoren). J. Bache-Wig and O. S. Bragstad. Describing the construction of curves for the determination of hysteresis and eddy-current losses. 2000 w. Zeitschr f Elektrotechnik—Dec. 3, 1905. No. 73864 B.

The Separation of Iron and Friction Losses in Direct Current Machinery. F. Handley Page. Principally describes a modification of the Kapp method showing results obtained. 900 w. Elec Rev, Lond—Dec. 1, 1905. No. 73681 A.

Meters.

An Efficiency Meter for Electric Incandescent Lamps. Edward P. Hyde and H. B. Brooks. Describes the theory and operation of an instrument designed and constructed to meet the need of an efficiency meter in the photometric work of the Bureau of Standards. Also editorial. 5200 w. Elec Wld & Engr—Dec. 2, 1905. No. 73613.

An Induction Meter for Alternating Currents (Induktionszähler für Wechselstrom). A report of the Reichsanstalt upon an alternating-current meter of the Siemens-Schuckert Company for currents from 5 to 300 amperes and pressures up to 600 volts; with details of construction. 1500 w. Elektrotech Zeitschr—Dec. 14, 1905. No. 73860 B.

Photometry.

The Theory and Practice of the Spherical Photometer (Das Kugelphotometer in Theorie und Praxis). Dr. L. Bloch. A full description of the Ulbricht photometer for the direct measurement of the mean spherical intensity of a source of light, with examples of its application. Two articles. 10000 w. Elektrotech Zeitschr—Nov. 16, 23, 1905. No. 73851 each B.

Testing.

Testing Electrical Machinery. An editorial explaining the methods used, especially the Hopkinson test, the Swinburne test, and the method devised by Dr. Charles V. Drysdale. 1400 w. Elec Rev, N Y—Dec. 9, 1905. No. 73640.

The Commercial Testing of Small Motors up to 15 B. H. P. Read before the Newcastle Sec. of Inst. of Elec. Engrs. Explains the tests usually made on motors of this size, and describes the apparatus used. 4500 w. Elec Engr, Lond—Dec. 15, 1905. Serial. 1st part. No. 74044 A.

The Testing of Electric Generators and Motors. Dr. Charles V. Drysdale. An illustrated explanation of the methods of testing and the construction of the testing plant. 4800 w. Engng—Nov. 24, 1905. No. 73599 A.

MOTORS.

Induction Motors.

Core Losses in Induction Motors. R. E. Hellmund. Gives a method for determining the core losses for motors with phase-wound secondaries. 400 w. Elec Wld & Engr—Dec. 23, 1905. No. 74028.

Induction Motor Characteristics by the Vector Diagram. H. C. Specht. Gives a practical example of the use of the vector diagram in working up the characteristics of an induction motor. 1000 w. Elec Jour—Dec., 1905. No. 74075.

The Practical Application of the Heyland Diagram for Induction Motors. W. C. Way. Gives description of the use of the "circle diagram" in design of induction motors, with figures and tables. 1500 w. Elec Wld & Engr—Dec. 23, 1905. No. 74027.

Motor Design.

Design of a Battery Motor. Clarence W. Coleman. Illustrates and describes a motor designed by the writer for operating railroad semaphore signals, though capable of application to other uses. 2000 w. Am Elect'n—Dec., 1905. No. 73566.

Railway Motors.

A 75 Horse Power Continuous Current Railway Motor for High Voltages (Ein 75 P. S. Gleichstrom Bahnmotor für Hochspannung). H. Rikli-Kehlstadt. Details of windings for a continuous-current motor to be operated at 1,500 volts; with curves and tables of its performance. 2000 w. Schweiz Bauzeitung—Nov. 25, 1905. No. 73871 B.

Shunt-Wound Tramway Motors. A. Johnston. Some points on the working of shunt-wound motors, especially in tramway service. 2200 w. Elec Engr, Lond—Dec. 1, 1905. No. 73679 A.

We supply copies of these articles. See page 709.

Single Phase.

The Arrangement of Windings in Single-Phase Motors (Die Zerlegung der Amperewindungen des Einphasenmotors). Adolf Thomälen. A general study of the theory of the single-phase motor, with analytical and graphical investigation of the windings of rotor and stator. Two articles. 12000 w. Elektrotech Zeitschr—Dec. 7, 14, 1905. No. 73856 each B.

TRANSMISSION.

Analogy.

Belt Transmission of Power as an Analogue of Electric Transmission. Byron B. Brackett. Develops an analogy between the electric transmission and the belt drive. Also editorial. 3500 w. Elec Wld & Engr—Dec. 9, 1905. No. 73666.

Arresters.

Protective Apparatus. N. J. Neall. Illustrates and describes the principal forms of arresters used on the Continent. 1200 w. Elec Jour—Dec., 1905. No. 74076.

Circuits.

Transmission Circuit. Charles F. Scott. An elementary consideration of self-induction, regulation and mutual induction. The first of a series of articles treating generally of induction and capacity in electric circuits. 4500 w. Elec Jour—Dec., 1905. No. 74072.

Earth.

Use of the Earth in High-Tension Transmissions. Emile Guarini. An account of the results obtained by M. Thury and the French commission of electricians, with remarks. 1600 w. Sci Am Sup—Dec. 30, 1905. No. 74063.

South Africa.

The Electrical Transmission of Power from the Victoria Falls to the Rand. Prof. W. E. Ayrton. From *The Times* Engng. Sup. Gives the writer's views in regard to this scheme, and compares them with the views of Mr. Wilson Fox. 2000 w. Mech Engr—Nov. 25, 1905. No. 73587 A.

The Zambesi Power Scheme. W. B. Esson. Discusses the scheme proposed by H. Wilson Fox. 1700 w. Elec Rev, Lond—Dec. 15, 1905. No. 74047 A.

Surging.

Oscillographic Researches on Surging in High Tension Lines. C. David. Abstracted, with introduction by L. A. Herdt. Deals with the subject of surges on transmission lines, giving the results of experiments. Ills. 2200 w. Can Soc of Civ Engrs—Nov. 2, 1905. No. 73744 D.

Temperature Effects.

Temperature Effects in Spans. C. P. Nachod. Showing the relation between the sag and tension in a span where there is a temperature variation. 700 w. Elec Wld & Engr—Dec. 7, 1905. No. 73667.

Vermont.

Electric Transmission and Distribution in Vermont. An illustrated description of the hydro-electric generating station and sub-stations of the Chittenden Power Company at Rutland. 1500 w. Am Elect'n—Dec., 1905. No. 73561.

MISCELLANY.

Addresses.

Dr. W. M. Thornton's Inaugural Address to the Newcastle Section of the Institution of Electrical Engineers. Abstract. Discusses the science and art of engineering, the education of an engineer, &c. 2500 w. Elect'n, Lond—Nov. 24, 1905. No. 73598 A.

Mr. J. M. Munro's Inaugural Address to the Glasgow Section of the Institution of Electrical Engineers. (Abridged.) Historical review of early work and of electricity in civic service. 6000 w. Elect'n, Lond—Nov. 24, 1905. No. 73596 A.

S. L. Pearce's Inaugural Address to the Manchester Section of the Institution of Electrical Engineers. (Abridged.) A general survey of the year's work, noting advances made, and the problems yet unsolved. 8000 w. Elect'n, Lond—Nov. 24, 1905. No. 73597 A.

INDUSTRIAL ECONOMY

Contracts.

Government Contracts; Legal Pitfalls and How to Avoid Them. George A. King and William B. King. Gives the rules of importance in guiding contractors entering into contracts with the United States, in the present number. 3500 w. Eng Rec—Dec. 16, 1905. Serial. 1st part. No. 73917.

Co-operation.

Useful Co-operation. W. C. Kerr. Read at meeting of the district managers of the Westinghouse Electric & Mfg. Co. Considers the essentials of co-operation and the things that make it difficult. 4000 w. Elec Jour—Dec., 1905. No. 74073.

Education.

Factory Education. O. M. Becker. An introductory article discussing the education of factory operatives. 2500 w. Mach, N Y—Dec., 1905. Serial. 1st part. No. 73527 C.

We supply copies of these articles. See page 799.

Laboratory Courses in Engineering Schools. Prof. D. S. Jacobus. Quotes from paper by Prof. Charles E. Lucke, before the A. S. M. E., and gives the discussion presented by the writer, which describes the work at Stevens Inst. 5000 w. Stevens Ind—Oct., 1905. No. 73929 D.

Teaching Agricultural Engineering in Land Grant Colleges. C. J. Zintheo. Shows the need of a complete course of agricultural engineering and what it should include, comparing the United States, with European countries, to the former's disadvantage. Especially discusses the need of instruction in the use and care of farm machinery. 2500 w. Eng News—Dec. 21, 1905. No. 73980.

Germany.

The American and the German Peril. Louis J. Magee. A comparison of American and German industrial methods, with especial emphasis upon the value of the interchange of experiences. 4000 w. Engineering Magazine—Jan., 1906. No. 73890 B.

Inventions.

The Real Want and Commercial Value of Potential Inventions. F. C. Fraentzel. Statements bearing on inventions as an investment and the real want and commercial value of patented inventions to both the inventor and investor, based on an experience of twenty years in obtaining letters-patent. 2500 w. Stevens Ind—Oct., 1905. No. 73927 D.

Iron Industry.

A Review of Conditions in the American Iron Industry. Edwin C. Eckel. A critical review of the statistics of iron manufacture in the United States during 1903, 1904, and 1905, with tables and diagrams. 3500 w. Engineering Magazine—Jan., 1906. No. 73892 B.

Iron Ore.

The Lake Superior Iron Ore Trade in 1905. Dwight E. Woodbridge. A report of the most prosperous year yet recorded, the production exceeding the previous year by more than 6,000,000 tons. 4000 w. Ir Age—Dec. 28, 1905. No. 74024.

Labor.

The Fight for the Open Shop. Isaac F. Marcosson. An account of the victory of organized employers over labor unions, and the protection of non-union men. Ills. 5000 w. World's Work—Dec., 1905. No. 73736 C.

Manufacturing.

The Engineer in Manufacturing Industries. Walter S. Graffam. Explains what is meant by manufacturing industries, and the position which the engineer holds in relation to manufacturing. 3000 w. Elec Rev, N Y—Dec. 9, 1905. No. 73641.

Mineral Industry.

The Relation of the Federal Government to the Mining Industry. C. N. Hays. Read at the El Paso meeting of the Am. Min. Cong. Endeavors to show what the federal government is now doing for this industry, and the directions in which it may safely expand its activities. 5000 w. Min Rept—Nov. 30, 1905. No. 73508.

Patents.

Some Phases of Our Patent System. W. R. Wood. Explains some points in the application for patents, and the reasons for them. 2200 w. Am Mach—Vol. 28, No. 49. No. 73648.

Water Transportation.

Water Transportation; Its Economic Importance. Frank Haigh Dixon. Discusses the economic importance of water transportation in the United States at the present time, under the heads of ocean, lake, river, and canal transportation. 10500 w. St Louis Ry Club—Nov. 10, 1905. No. 73758.

Works Management.

The Square Deal in Works Management. O. M. Becker. The first instalment of a serial; the present portion discussing the common-sense of the management of men. 3500 w. Engineering Magazine—Jan., 1906. No. 73894 B.

MARINE AND NAVAL ENGINEERING

Battleship.

U. S. Battleship Virginia. C. A. Gardiner. Description of the vessel, armament, machinery, &c. 5500 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73954 H.

Boilers.

See Mech. Engng., Steam Engineering.

Capstan.

New Electric Capstan at Antwerp. Illustrated description. 800 w. Sci Am—Dec. 30, 1905. No. 74060.

Central Plant.

Mechanical Plant of the New 23d St. Ferry Terminals, New York. Describes the central power plant and heating system that will serve the new terminals of the Lackawanna, the Erie, and the Central Railroad of New Jersey. Ills. 3500 w. Eng Rec—Dec. 2, 1905. No. 73572.

We supply copies of these articles. See page 799.

Electrical Devices.

Electricity in Service on British Battleships. Edward Nelson. An illustrated description of the electrical apparatus found on one of the British cruisers which recently visited New York. 2000 w. Elec, N Y—Dec. 6, 1905. No. 73546.

Floating Docks.

The Influence of Admission and Discharge of Water upon the Stability of Floating Docks (Ueber die Verminderung der Stabilität der Schwimmdocks durch die in denselben Vorhandenen Wasser-Ein-bezw.-Austrittsöffnungen). Alexander Dietzius. With diagrams showing the effect of various degrees of immersion upon the stability. 4000 w. Schiffbau—Nov. 22, 1905. No. 73870 D.

Gunboats.

Contract Trials of the U. S. Gunboat Paducah. A report of the standardization trials, and the performance on the preliminary trial. 1000 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73952 H.

Japan.

The Japanese Navy After the War. A report of the splendid results, with illustrations of the Russian warships refloated and captured. 2200 w. Sci Am—Dec. 16, 1905. No. 73727.

Landing Stage.

The Landing Stage at Lome. Illustrated description of this landing stage on the coast of the Gulf of Guinea, constructed by the German Government. 1700 w. Engr, Lond—Nov. 24, 1905. No. 73608 A.

Launches.

Problems in Connection with High-Speed Launches. Clinton H. Crane. Discusses the shape of the under water form; the skimming idea, and other points in design. Ills. 1500 w. Rudder—Dec., 1905. No. 73578 C.

Lifeboats.

The Evolution of the Lifeboat. Capt. C. H. M'Lellan. A review of the development of the lifeboat, dating back to 1785, with illustrations. 2000 w. Marine Engng—Jan., 1906. No. 74020 C.

Liners.

The Construction of a Great Liner. A half-dozen illustrations showing clearly a great ocean steamship in the earlier stages of construction, with comments. 800 w. Engr, Lond—Dec. 8, 1905. No. 73908 A.

The Launch of the Empress of Britain. Illustrated description of a fine vessel that is to be placed in service between Britain and Canada. 2200 w. Marine Engng—Jan., 1906. No. 74022 C.

The New Hamburg-American Liner Amerika. An illustrated detailed description of this large and luxurious steamer recently put in service. 1200 w. Marine Engng—Dec., 1905. No. 73515 C.

Machinery Weights.

Weights of Machinery. W. F. Sicard. A discussion of machinery weights in relation to shipbuilding, limited to what is commonly included in the term. 9200 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73950 H.

Motor Boats.

A Suction Gas Plant Boat. From *Zeit. d. Ver. Deut. Ing.* Illustrates and describes the boat Lotte, used in the carrying trade between Cologne, Antwerp, and Rotterdam. 800 w. Engr, Lond—Dec. 1, 1905. No. 73693 A.

The Power Boat in 1905. W. P. Stephens. A review of the year, and the progress in the field of design. Ills. 3800 w. Rudder—Dec., 1905. No. 73577 C.

Naval Training.

The New Scheme of Training Naval Officers. A short account of the training given in the Royal Naval College, at Osborne; and abstracts from a recent "Statement of Admiralty Policy," referring principally to the training of engineer officers for the Navy. 6500 w. Engr, Lond—Dec. 8, 1905. No. 73912 A.

Paddlewheel.

A Motor Paddlewheel for Small Boats. Translated from *La Vie Automobile.* Illustrates and describes a new stern wheel for propelling motor boats, recently experimented with in the Seine. 700 w. Sci Am Sup—Dec. 2, 1905. No. 73559.

Ship Construction.

Pneumatic Tools as Applied to Ship Construction. C. Schofield. Abstract of a paper read before the N.-E. Coast Inst. of Engrs. & Shipbuilders. An explanation of the methods adopted in the American shipyards as to the application of pneumatic tools in ship construction. Ills. 2500 w. Mech Engr—Dec. 9, 1905. No. 73799 A.

Shipyards.

Tershana—A Turkish Shipyard. An interesting description, showing the worthlessness of the yard, the financial condition, &c. 1300 w. Engr, Lond—Dec. 8, 1905. No. 73910 A.

South Africa.

The Ports of South Africa—Cape Town and Durban. Reviews the history of harbor construction on the coast of South Africa, and describes the recent improvements. Map. 3000 w. Engng—Dec. 8, 1905. No. 73905 A.

Speed Recorder.

New Electrical Speed Recorder. H. C. Dinger. An illustrated description of the Monitor Speed Recorder, which aims to

We supply copies of these articles. See page 799.

indicate accurately the rate of speed of a vessel. 4500 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73953 H.

Torpedo.

The New Bliss-Leavitt Torpedo. S. D. V. Burr. Brief descriptions of the Howell torpedo, and the Russian torpedo, with illustrated detailed description of the Bliss-Leavitt torpedo. 2200 w. Ir Age—Dec. 14, 1905. No. 73720.

Torpedo Boats.

Thornycroft 120-Horse-Power Gasoline-Propelled Torpedo Launch. Brief illustrated description. 600 w. Sci Am—Dec. 30, 1905. No. 74061.

Torpedo Boat No. 20, Goldsborough. G. H. Thayer. Detailed description, with report of official trial performance. 5000 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73948 H.

Turbine Steamers.

Recent Turbine Steamers. Illustrations and short descriptions of the Manxman, Princesse Elisabeth, Maheno, and a new vessel for King Edward VII. 2400 w. Marine Engng—Dec., 1905. No. 73516 C.

The Turbines of the "Carmania." Illustration of this new steamship, with description of the turbine machinery. 1500 w. Sci Am—Dec. 23, 1905. No. 73985.

The New Turbine Liner Carmania. An illustrated description of the largest turbine steamer yet constructed. 4000 w. Marine Engng—Jan., 1906. No. 74019 C.

Triple-Screw Turbine-Driven Cunard Liner "Carmania." A fully illustrated detailed description of this large vessel for service on the Atlantic, with report of trials. 15000 w. Engng—Dec. 1, 1905. No. 73688 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air-Cooled.

A 100-H. P. Two-Cycle Air-Cooled Motor. Illustrated description of a motor built for a western railroad which is the largest of this type built in the United States. 2000 w. Automobile—Dec. 7, 1905. No. 73637.

Automobile Lessons.

Elementary Lessons on Motor Cars. K. D'Esterre-Hughes. The first of a series of six lectures which R. Sedgwick Currie gave before the Ladies' Automobile Club of Great Britain and Ireland. The subject of the present lecture is "The Engine." 2500 w. Autocar—Dec. 9, 1905. Serial. 1st part. No. 73796 A.

Cleveland.

Cleveland 30-35 Horse-Power Model F. Illustrated detailed description. 1200 w. Automobile—Dec. 28, 1905. No. 74082.

Construction.

Automobile Construction. F. C. Mason. The first of a series of articles which will give an illustrated description of a light gasolene touring car, and also a runabout which will be cheap and easy to build. 600 w. Am Mach—Vol. 28, No. 51. Serial. 1st part. No. 73977.

Converting Apparatus.

Apparatus for Charging Storage Batteries. Illustrates and describes a device, especially suited to automobile battery charging, based on the discovery that the vapor given off by mercury when heated will provide a path for the passage of current in one direction only. 2000 w. Automobile—Dec. 14, 1905. No. 73761.

Daimlers.

English Daimlers for American Market. An illustrated description of the main features of these cars, which differ somewhat from the English form. 2000 w. Automobile—Nov. 30, 1905. No. 73506.

De Dietrich.

The New 12-15-H. P. De Dietrich Car. Illustrated detailed description of the new chassis, the engine, &c. 800 w. Auto Jour—Nov. 25, 1905. Serial. 1st part. No. 73584 A.

Engines.

Automobile Engines Considered from the Operative Point of View. Rodolphe Mathot. A scientific discussion of the design of the internal-combustion engine for the automobile, based on fundamental principles. 4000 w. Engineering Magazine—Jan., 1906. No. 73895 B.

Exhibition.

Motor Car Exhibition at Olympia. An illustrated review of this exhibition, its striking features, and more interesting exhibits. 3800 w. Engr, Lond—Nov. 24, 1905. Serial. 1st part. No. 73605 A.

The Olympia Exhibition. A general account of this very successful automobile exhibition, with illustrations of many of the exhibits, and comments on the progress. 4500 w. Auto Jour—Nov. 25, 1905. No. 73582 A.

Industrial Vehicles.

Electric Vehicles for Semi-Public Service. Illustrated description of express wagons equipped with trolley pole and

special electric motor, for using current from the over-head feed wires of street railway companies. 1300 w. Automobile—Dec. 14, 1905. No. 73760.

Knox.

Knox Air-Cooled Motor-in-Front Car. Illustrated description of a new high-powered touring car with a vertical air-cooled motor in front, known as Model G. 1600 w. Automobile—Dec. 28, 1905. No. 74081.

Lamps.

New Ideas in French Lamps. Illustrates and describes the Besnard lamp and projector, and the Bleriot lamp burning gasoline and oxygen. 1000 w. Automobile—Nov. 30, 1905. No. 73505.

Omnibuses.

Gaso-Electric Equipment for Fifth Avenue Bus. Illustrates and describes the motive power equipment of this thirty-passenger vehicle. 1500 w. St Ry Jour—Dec. 2, 1905. No. 73520 C.

Motor Omnibuses at the Olympia Exhibition. An illustrated review of the exhibits, showing recent progress. 4500 w. Tram & Ry Wld—Dec. 7, 1905. No. 73973 B.

The "S 41" Type Petrol Omnibus. Illustrates and describes a type notable for the manner in which the engine may be used as a brake. 1200 w. Auto Jour—Dec. 9, 1905. No. 73797 A.

Runabout.

Reo Runabout with Folding Rear Seat. Illustrated description of an 8-horsepower American light car. 1500 w. Automobile—Dec. 14, 1905. No. 73763.

Siddeley.

The Siddeley 32-Horse-Power Motor-Car. Illustrated description of the châssis and mechanism of this car which was exhibited at Olympia. 3500 w. Engng—Dec. 8, 1905. No. 73906 A.

Thomas.

Thomas 50-Horsepower Flyer for 1906. An illustrated article describing the detail changes in designing the 1906 car. 1700 w. Automobile—Dec. 21, 1905. No. 73998.

Touring Car.

New Columbia 28 H. P. Touring Car. Illustrated description of a new gasoline car to be known as Mark XLVI. Notes its interesting features. 2000 w. Automobile—Dec. 14, 1905. No. 73762.

Winton.

The 1906 Winton Cars. Begins an illustrated description of these cars in which the vertical type of engine has been adopted. 900 w. Auto Jour—Nov. 25, 1905. Serial. 1st part. No. 73583 A.

COMBUSTION MOTORS.

Automobile Engines.

See Mechanical Engng., Automobiles.

Diagram.

A New Work Diagram for Gases. Frank Foster. Describes a diagram devised to illustrate the actions of, and simplify the calculations for gas turbines, turbo compressors, gas engines, air compressors, and hot air engines. 2000 w. Engr, Lond—Dec. 1, 1905. No. 73694 A.

Gasoline Motor.

Alterno-Rotative Gasoline Motor. Illustrated description of the new Primat motor. The movement is produced by a set of pistons working alternately in a circular chamber, and the to-and-fro action is transformed to a rotary movement by means of a crank. 900 w. Sci Am Sup—Dec. 2, 1905. No. 73560.

Gas Power.

Electric Power from Blast Furnace Gas. H. Freyn. From a paper read before the W. Soc. of Engrs. Notes the quantity of gas used for the various purposes of the blast furnace plant, showing that a little less than 50 per cent. is available for use outside the plant. Discusses the cost of the electric power station and installation, operation, &c. 4000 w. Ir Age—Dec. 28, 1905. No. 74025.

The Use of Gas for Power and Heating. Ernest A. Dowson. Abstract of a paper read at the Birmingham Assn. of Mech. Engrs. Considers the advantages of gas-engines and plant, describing the properties and manufacture of gases which are economical for industrial use, in the present number. 4000 w. Sci Am Sup—Dec. 9, 1905. Serial. 1st part. No. 73635.

Gas Producers.

Reversed-Combustion Gas Producers (Gazogènes à Combustion Renversée). J. Deschamps. A review of the work of the late M. Lencauchez, with especial reference to the reversed draft producer for generating fuel gas. 7500 w. Mem Soc Ing Civ de France—Oct., 1905. No. 73881 G.

The Gas Producer for Heating Processes. William B. Chapman. Describes the American gas producer and gives some of the applications made of it with marked economy and advantage. 2000 w. Sci Am—Dec. 23, 1905. No. 73983.

The Suction Type of Gas Producer. Abstract of a paper by C. H. Treglown, read before the S. Staffordshire and Warwickshire Inst. of Min. Engrs. Describes the Tangye suction gas plant, discussing factors affecting the working and the advantages. 3000 w. Col Guard—Dec. 15, 1905. No. 74052 A.

We supply copies of these articles. See page 799.

Packing.

An Improved Method of Packing the Cylinder Head of a Gasoline Engine. From the *English Mechanic and World of Science.* Directions for successful packing are given. 700 w. Sci Am Sup —Dec. 2, 1905. No. 73556.

Suction Gas.

A Successful Suction Gas Producer Central Station Plant. An illustrated description of a plant at Newton, N. J., which furnishes current for lighting and power for a town of 5,000 inhabitants. 2000 w. Power—Dec., 1905. No. 73710 C.

Suction-Gas Producers. Prof. A. Humboldt Sexton. Illustrates and describes four forms of suction gas producers, explaining the principles on which suction producers are based. 3800 w. Mech Engr —Dec. 9, 1905. No. 73798 A.

The Davey-Paxman Suction-Gas Plant and Gas Engine. Illustrated detailed description. 2200 w. Engng—Nov. 24, 1905. No. 73600 A.

The Thompson-Burger Gas Producer and Engine. Illustrated description of this automatic cut-off gas engine and the suction gas producer. 2000 w. Ir Age—Dec. 21, 1905. No. 73940.

Testing.

Study of a Gasoline Engine Test. P. F. Walker. Describes investigations made by students for graduating theses, stating the object of the tests, describing apparatus and methods used, and discussing results. Ills. 4500 w. Engr, U S A —Dec. 15, 1905. No. 73788 C.

Testing High Power Modern Gas Engines. William H. Spiller. Read before the Tech. Soc. of Kansas City, Mo. An account of the severe test in the factory which the modern gas engine has to undergo. 1300 w. Min Wld—Dec. 23, 1905. No. 74006.

Turbines.

The Gas Turbine (Les Turbines à Gaz). A. Berthier. A general description of the present status of the gas turbine question, with reference to the turbines of Stolze and of Armengaud and Lemale. 2500 w. Génie Civil—Dec. 2, 1905. No. 73814 D.

HEATING AND COOLING.

Boilers.

Elements of Commercial Value in Household Boilers. J. M. W. Kitchen. Discusses the desirable requirements in a household water or steam heater. 2000 w. Met Work—Dec. 9, 1905. No. 73611.

Heat Units.

The Heat Unit and Its Application to the Heating of Buildings. George G. Bennett. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Gives method of finding the loss of heat units, illustrating by example. 800 w. Engr, U S A—Dec. 1, 1905. No. 73620 C.

Refrigeration.

Pipe Line Refrigeration. J. E. Starr. Address before the Am. Soc. of Refrig. Engrs. Reviews the work done in pipe line distribution, both those using brine circulation and those using direct expansion, the problems in connection with such systems and the progress made in solving them. 2500 w. Eng News—Dec. 14, 1905. No. 73734.

1,000 Horse Power Refrigerating Machine (1,000 Pferdige Kältemaschine). G. Döring. A description of the Boyle machine at the Quincy Market cold storage warehouse in Boston. 1800 w. Zeitschr d Ver Deutscher Ing—Dec. 2, 1905. No. 73806 D.

Train Heating.

See Railway Engineering, Motive Power and Equipment.

HYDRAULICS.

Flow.

The Gaging of Streams by Chemical Means. W. L. Butcher. Brief remarks on the usefulness of this method and how to carry it out, also suggesting a method of using aniline dyes. 1100 w. Eng News—Dec. 14, 1905. No. 73733.

Governors.

The Speed Regulation of Turbines (Die Geschwindigkeitsregulierung der Turbinen). A. Budau. A review of the improvements which have been made during the past thirty years, with especial reference to Continental practice. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 17, 1905. No. 73820 D.

Plumbing.

Plumbing in the Butterick Building, New York. Illustrated detailed description of the water supply and drainage system in a large mercantile and office building. 2000 w. Met Work—Dec. 9, 1905. No. 73610.

Pumping.

Pumping Engines and Pumping Machinery. Oscar F. Rabbe. Read before the Ohio Soc. of Mech., Elec., & Steam Engrs. Discussing some of the sources of trouble, the data that should be included in specifications, &c. 1500 w. Engr, U S A—Dec. 1, 1905. No. 73619 C.

Turbine Plants.

Foreign and American Hydraulic and Turbine Plants. Frank C. Perkins. Gives illustrations and brief descriptions of plants showing the arrangement of horizontal shaft turbines, and vertical shaft turbines, and the types of governors

employed. 1700 w. Engr, U S A—Dec. 1, 1905. No. 73615 C.

Turbines.

Hydraulic Turbines (Turbines Hydrauliques). M. Abraham. A general examination of the various types of turbine watch wheels, with a mathematical discussion of the mechanical principles involved in turbine design. Serial. Part I. 3000 w. Revue Technique—Oct. 25, 1905. No. 73832 D.

The Distribution of Pressure in the Francis Turbine, and the Pressure on the Step (Die Druckverhältnisse in der Francis Turbine und der Druck auf den Spurzapfen). Karl Kobes. A mathematical investigation of the action of the water-pressure in turbines of the Francis type, with especial reference to the load on the spindle step. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 8, 1905. No. 73825 D.

Water Power.

Water-Power Plants; Common Troubles, Causes, and Remedies. W. E. Crane. A brief discussion of early plants, of shape of dams, and the remedies for various troubles. Ills. 1700 w. Power—Dec., 1905. No. 73700 C.

MACHINE WORKS AND FOUNDRIES.

Arsenal.

The United States Arsenal at Frankford. F. A. Stanley. Begins an illustrated detailed description of this arsenal, at Philadelphia, its equipment and manufactures. 2300 w. Am Mach—Vol. 28, No. 50. Serial. 1st part. No. 73765.

Bearings.

Experimental Determination of the Relative Value of Short Bearings. Reports some experiments made by H. E. Hayward for the Link Belt Engng. Co. which show that, under the conditions of chain links, the usual assumption is not correct. Ills. 1000 w. Am Mach—Vol. 28, No. 52. No. 74035.

Boring Mill.

A New Bullard Boring Mill. Illustrated description of a new 54-inch rapid production boring and turning mill, noting its features of interest. 1500 w. Ir Age—Nov. 30, 1905. No. 73517.

Cams.

The Double Cam System of the Monotype. Illustrated detailed description of the system used and the cam-cutting machine. 2000 w. Am Mach—Vol. 28, No. 50. No. 73766.

Castings.

Casting Non-Ferrous Metals. From *Eisen Zeitung*. Suggestions for successful work in the casting of bronze, brass, copper, and various alloys. 1000 w. Mech Engr—Nov. 25, 1905. No. 73589 A.

Open Hearth Steel Castings. W. M. Carr. The first of a series of articles treating of the important points of their manufacture by the acid and by the basic open hearth processes. 3000 w. Foundry—Dec., 1905. Serial. 1st part. No. 73944.

Steel Castings and the Constitution of Steel. Percy Longmuir. Discusses the effect of various constituents and methods on the structure and qualities. Ills. 1500 w. Ir Trd Rev—Nov. 30, 1905. No. 73503.

Strength of Hydraulic Press Castings. Frank B. Kleinhans. Describes the work of forming steel plates into various shapes by the hydraulic press. Diagrams. 700 w. Ir Trd Rev—Nov. 30, 1905. No. 73504.

Why Castings Curve. From the *English Mechanic and World of Science*. Discusses the causes and remedies. Ills. 2500 w. Sci Am Sup—Dec. 16, 1905. No. 73729.

Dies.

Folding or Bending Dies. Carroll Ashley. Illustrates and describes dies which will not stretch or distort the metal. 1000 w. Am Mach—Vol. 28, No. 49. No. 73646.

Drawing Office.

The Organization of a Drawing Office. W. O. Horsnaill. Describes a system applicable to drawing-offices dealing with all kinds of engineering work. Ills. 2500 w. Engr, Lond—Dec. 1, 1905. Serial. 1st part. No. 73692 A.

Drawings.

The Reproduction of Drawings of Great Length or Number. L. F. Rondinella. A review of the methods for making long prints, giving illustrated descriptions of several continuous-printing machines and their working. Also general discussion. 5800 w. Pro Engrs' Club of Phila—Oct., 1905. No. 73938 D.

Electric Driving.

The Applications of Electricity in the Royal Gun Factory, Woolwich Arsenal. Col. H. C. L. Holden. Read before the Inst. of Elec. Engrs. Illustrates and describes applications of electricity and the methods, some of which are a departure from ordinary practice. 3000 w. Elec Engrs, Lond—Nov. 24, 1905. Serial. 1st part. No. 73592 A.

Facings.

Foundry Facings. W. G. Scott. Read before the A. F. A. Convention. Describes the different grades of material, and gives a suitable method for testing the quality. 4500 w. Foundry—Dec., 1905. No. 73946.

We supply copies of these articles. See page 799.

Foundry.

Tendencies in the Foundry Industry. Dr. Richard Moldenke. Read before the New England Foundrymen's Assn. Considers the tendency toward multiple operations, sand treatment, standardizing, steel scrap, ferro alloys, the electric furnace, and the direct metal process. 3800 w. Ir Age—Dec. 21, 1905. No. 73941.

Forgings.

The Manufacture of Forgings. Frank Somers. Read before the Staffordshire Iron & Steel Inst. A review of the tools used to save human labor in the manufacture of iron forgings from the earliest invention to the present. 2500 w. Ir & St Trds Jour—Dec. 16, 1905. No. 73990 A.

Jigs.

Two V-Block Drill Jigs. A. B. Christman. Sketches and description of jigs for drilling holes in ¼-inch rolled shafting are given, and the method of correctly locating the drill bushings is also described. 700 w. Am Mach—Vol. 28, No. 49. No. 73647.

Joints.

Designing of Riveted Joints. Charles E. Frick. Some suggestions helpful in designing joints and testing their efficiency. 1500 w. Boiler Maker—Dec., 1905. No. 73638.

Lathes.

Lathes for the Amateur. From the *English Mechanic and World of Science.* Considers the principal points to be settled in buying a lathe. Ills. 4000 w. Sci Am Sup—Dec. 9, 1905. No. 73634.

Machine Design.

Design and the Safety of Machinery. Edward Crowe. Abstract of a paper read before the Cleveland Inst. of Engrs. and of the discussion. Considers the influence of design on the strength and safety. 2500 w. Ir & Coal Trds Rev—Dec. 15, 1905. No. 74059 A.

Molding.

Modern Molding Machines (Moderne Formmaschinen). H. Baur. A very fully illustrated account of the development of the modern moulding machine, with especial reference to German practice. Two articles. 5000 w. Stahl u Eisen—Nov. 15, 1905. No. 73848 each D.

Molding Machine Practice. F. W. Hall, in *The Patternmaker.* Illustrates and describes work that required the getting up of a special device. 1500 w. Foundry—Dec., 1905. No. 73945.

Molding Materials in the Foundry. E. L. Rhead. Considers the points of importance in selecting suitable materials for making molds. 3000 w. Mech Engr—Nov. 25, 1905. No. 73586 A.

Patterns.

The Care of Patterns. Robert Grimshaw. Considers the classification and storage of foundry patterns, their designation, marking, and care. 2400 w. Ir Age—Dec. 21, 1905. No. 73943.

Records.

Mechanical Department Records—The Graphic System. L. A. Larsen. Presents the merits of the graphic system, explaining its use. 2000 w. Am Engr & R R Jour—Dec., 1905. No. 73532 C.

Saw.

The Toothless Cold Saw. E. D. Sewall. Gives an experience in repairing a cross cut saw of very hard plate, with comments by Prof. Benjamin Silliman of Yale College, experiments, and applications of the method. 3000 w. Ir Age—Dec. 21, 1905. No. 73942.

Shops.

The Works of the F. Wesel Manufacturing Company. Illustrated description of interesting works where machines and tools used by electrotypers and stereotypers, and by printers and photo-engravers are made. The individual motor drive is employed throughout. Some of the methods are also described. 2200 w. Am Mach—Vol. 28, No. 51. No. 73976.

Thermit.

Thermit Practice in America. E. Stütz. An account of the progress made within the past eighteen months, in the introduction in the United States of the Thermit process as applied in various engineering and mechanical arts. Ills. 5000 w. Jour Fr Inst—Oct., 1905. No. 73934 D.

Tools.

Tools for Machining Segments. Edward Snyder. Illustrates and describes tools and methods used. 2000 w. Am Mach—Vol. 28, No. 52. No. 74036.

Turret Machine.

The Prentice Multiple Spindle Automatic Turret-Machine. Illustrates and describes a machine for boring, turning, drilling, reaming, and threading small castings, forgings or pieces that have been finished on one end in a rod machine and require operation on the reverse end. 1200 w. Ir Age—Nov. 30, 1905. No. 73518.

Welding.

Autogenous Welding (La Soudure Autogène). Report of the Laboratory of the Conservatoire des Arts et Métiers upon the oxy-acetylene blowpipe for welding plates and structural members of iron and steel. 3000 w. Revue Technique—Nov. 25, 1905. No. 73838 D.

Works Management.

See Industrial Economy.

We supply copies of these articles. See page 799.

MATERIALS OF CONSTRUCTION.

Alloys.

Iron-Nickel-Manganese-Carbon Alloys. Abstract of the seventh report to the Alloys Research Committee on the properties of these alloys, by Dr. H. C. H. Carpenter, R. A. Hadfield and Percy Longmuir. 2500 w. Engr, Lond—Nov. 24, 1905. No. 73607 A.

Seventh Report to the Alloys Research Committee: On the Properties of a Series of Iron-Nickel-Manganese-Carbon Alloys. Dr. H. C. H. Carpenter, R. A. Hadfield, and Percy Longmuir. An account of the investigations made and results obtained. Ills. 22000 w. Inst Mech Engrs—Nov. 17, 1905. No. 73747 D.

The Equilibrium Diagram of the Iron-Carbon Alloys (Sur le Diagramme d'Equilibre des Alliages Fer-Carbone). Georges Charpy. A study of the cooling curves of the iron-carbon alloys, with a view to determine the law of cooling. 1800 w. Comptes Rendus—Dec. 4, 1905. No. 73831 D.

Amalgams.

Amalgams: Their Composition, Properties, Preparation, and Uses. From the French of Leon de Mortillet. Discusses the general properties of amalgams and applications made of them. 3500 w. Sci Am Sup—Dec. 23, 1905. No. 73986.

Boiler Materials.

Materials for Boilers. J. Rowland Brown. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. An examination of specifications of materials of boilers and their requirements. 6000 w. Engr, U S A—Dec. 1, 1905. No. 73618 C.

Chromium.

The Use of Ammonium Persulfate in the Determination of Chromium in Steel. Harry E. Walters. Gives an outline of method used by the writer, applicable for ordinary chrome steel, but not for tungsten or molybdenum steels. 1000 w. Pro Engrs' Soc of W Penn—Dec., 1905. No. 74065 D.

Lubricants.

Friction, Lubricants and Lubrication. Stanley H. Moore. Discusses these subjects in detail. 3000 w. Power—Dec., 1905. No. 73708 C.

Oils and Oiling. H. R. Carter. The various kinds of oil are discussed and their value as lubricants, illustrating instruments used in testing them. 2400 w. Prac Engr—Dec. 15, 1905. Serial. 1st part. No. 74040 A.

Shear.

Behavior of Materials of Construction Under Pure Shear. E. G. Izod. A report of experimental tests made of the better known and commercially used materials. 3300 w. Ills. Inst of Mech Engrs—Dec. 15, 1905. No. 74064 D.

MEASUREMENT.

Dynamometer.

A Dynamometric Brake for the Measurement of the Power of Motors (Sur un Frein Dynamometrique Destiné à la Mesure de la Puissance de Moteurs). A. Krebs. Describing a form of electric brake permitting the utilization of the greater portion of the power developed. 1500 w. Comptes Rendus—Nov. 13, 1905. No. 73827 D.

Inertia.

The Determination of the Moment of Inertia of Revolving Bodies (Bestimmung der Trägheitsmomente von Umdrehungungskörpern). Sigmund Wellisch. A graphical and analytical study, with practical applications to bodies of various forms. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 24, 1905. No. 73823 D.

Measuring Machine.

Recent Improvements in the Newall Measuring Machine. Illustrates and describes the new features recently introduced and the increase in size, the latest machine having a capacity of six feet. 900 w. Am Mach—Vol. 28, No. 48. No. 73539.

Pitot Tube.

Experiments with the Pitot Tube in Measuring the Velocities of Gases in Pipes. R. Burnham. A report of experimental investigations, describing the method used and presenting the results obtained as showing the practical accuracy of which the Pitot tube is capable. 2500 w. Eng News—Dec. 21, 1905. No. 73981.

Testing Machine.

A 600,000-Pound Screw-Testing Machine. Illustrated detailed description of a fine machine recently completed for the University of Illinois. 1000 w. Am Mach—Vol. 28, No. 51. No. 73975.

Thermometers.

Thermometers, Pyrometers, and Thermo-Regulators Operated by the Pressure of Saturated Vapors. Illustrates and describes apparatus of various types for exact determination of temperature. 4000 w. Sci Am Sup—Dec. 16, 1905. No. 73731.

POWER AND TRANSMISSION.

Ball Bearings.

The Hoffmann Manufacturing Co.'s Patent Ball Bearings and Steel Balls. An illustrated description of the construction and application of their patent ball bearings. 1500 w. Prac Engr—Dec. 1, 1905. No. 73677 A.

We supply copies of these articles. See page 799.

Bearings.

Bearings. A topical discussion. 3300 w. Pro Engrs' Soc of W Penn—Dec., 1905. No. 74066 D.

Coal Handling.

Coal Handling Plant at the Hoboken Terminal of the Lackawanna R. R. Illustrates and describes the two McMyler car dumping machines installed and their operation. 2800 w. Eng Rec—Dec. 9, 1905. No. 73670.

Compressed Air.

A Central Compressed Air Power Plant for Heavy Railroad Construction. Lucius I. Wightman. Illustrates and describes the plant for carrying out the heavy work on the low-grade freight line of the P. R. R. near Safe Harbor, Pa. 2500 w. Compressed Air—Nov., 1905. No. 73735.

Air Power in the Union Pacific Shops at Omaha, Neb. Illustrates and describes some of the applications of compressed air. 1000 w. Mod Mach—Dec., 1905. No. 73698.

Cone-Pulley.

Cone-Pulley Design. John Edgar. Gives as simple a method as possible for so designing cone-pulleys that their ratios shall advance in geometrical progression. 1400 w. Am Mach—Vol. 28, No. 50. No. 73767.

Cranes.

The Wharf Cranes of the Pennsylvania Railroad Company at Greenville, N. J. John Lyle Harrington. Illustrations, with detailed description of cranes for handling freight, both bulk and package, between the railway cars and the vessels. 3000 w. Can Soc of Civ Engrs—Nov. 16, 1905. No. 73746 D.

Electric Driving.

A Discussion of the Various Systems of Electric Motor Driving. E. Kilburn Scott. Briefly considers belt driving, spur gearing, special cam gearing, worm gearing, chains, and friction gearing. Ills. 2400 w. Ir & Coal Trds Rev—Dec. 8, 1905. No. 73915 A.

Elevators.

A Special Air Lift for Printing Press Service. A. W. Cochran. Illustrated description of an air-lift for supplying paper to a newspaper press, in Portland, Ore. 1000 w. Eng News—Dec. 7, 1905. No. 73629.

Tests of Elevator Plant in the Trinity Building, New York. Illustrates and describes the elevator system installed in this 20-story building, giving a report of the tests made. 2500 w. Eng Rec—Dec. 16, 1905. No. 73918.

Hoisting.

A Study of Hoisting Machinery (Etude sur les Appareils de Levage). L. Rousselet. A general study of cranes and other mechanical hoisting devices; the first instalment discusses electric traveling cranes. Serial. Part I. 2000 w. Revue Technique—Nov. 10, 1905. No. 73835 D.

Prime Movers.

Prime Movers for Generators. W. H. Wakeman. An illustrated article calling attention to prime movers available for this purpose. Elec, N Y—Dec. 27, 1905. Serial. 1st part. No. 74008.

Speed-Changing.

Gear-Box Drives. H. T. Millar. Illustrates and describes several gear-box arrangements, some remarkable for the large number of changes obtainable, and others for the small number of gears in motion. 1100 w. Am Mach—Vol. 28, No. 50. No. 73768.

Unloaders.

Electrically Operated Ore Unloaders. Frank C. Perkins. An illustrated description of the labor saving devices used at the docks of the steel companies on the Great Lakes. 1600 w. Min Rept—Dec. 7, 1905. No. 73664.

Worm Drive.

The "Globoid" Worm Drive. Robert Grimshaw. Illustrated description of a new drive which has won success in Germany, for which is claimed 90 per cent. of useful effect. 400 w. Mach N Y—Dec., 1905. No. 73528 C.

STEAM ENGINEERING.

Adiabatic.

The Meaning of Adiabatic. Aims to show that three meanings are given to the word "adiabatic," and that this both confuses and misleads. 3000 w. Engr, Lond—Dec. 15, 1905. No. 74053 A.

Air Pumps.

Air Pumps for Marine Engines (Luftpumpen für Schiffmaschinen). C. Strebel. A general study of air-pump design, with numerous examples of modern types, both connected to the engine and independently driven. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 2, 1905. No. 72805 D.

Boiler-House.

Boiler-House Economy. A. W. Bennis. Abstract of a paper before the Engng. Soc., Huddersfield. Discusses points that require attention to prevent losses. 2800 w. Ir & Coal Trds Rev—Dec. 8 1905. No. 73914 A.

Boiler Power.

Boiler Power for Lighting and Power Plants. Charles L. Hubbard. Gives a method of estimating quickly the boiler

We supply copies of these articles. See page 799.

power required for heating, lighting or power purposes, giving results of sufficient accuracy for all practical purposes. 2000 w. Am Elect'n—Dec., 1905. No. 73567.

Boilers.

Blowing Down Boilers. W. H. Wakeman. An illustrated article considering neglected points in the care and operation of boilers. 2000 w. Power—Dec., 1905. No. 73706 C.

Boiler Inspection and Explosions. A. S. Atkinson. On some of the methods of inspection used by the steam boiler insurance companies. 2200 w. Boiler Maker—Dec., 1905. No. 73639.

Care, Use, and Design of Locomotive Boilers. Two papers, by George Austin, and by J. J. Malone, discussed together. 10400 w. Pro Pacific C Ry Club—Dec. 16, 1905. No. 73970 C.

Notes on the Performance of the Thornycroft Boiler in a Monitor. W. T. Cluverius. An account of the performance of the boilers of the harbor-defence monitor Arkansas. 1500 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73949 H.

Specification for Horizontal Tubular Boiler and Boiler-Room Equipment. Charles L. Hubbard. Gives a "dummy" useful in making up specifications for tubular boilers and their settings. 4500 w. Power—Dec., 1905. No. 73702 C.

The Care of Boilers. M. E. Wells. A discussion of the causes of leaks in boilers and the remedies. Ills. General discussion. 18000 w. Pro W Ry Club—Nov. 21, 1905. No. 73969 C.

The du Temple Water-Tube Boiler (Les Generateurs à Tubes d'Eau Système du Temple). H. Lassaux. Describing the general design of the du Temple small-tube boiler, with tabulated tests on French and Russian torpedo boats. 3500 w. Revue Technique—Nov. 10, 1905. No. 73836 D.

Boiler Tests.

Hydraulic Tests. William H. Fowler. Describes these tests for boilers and other vessels subject to steam pressure, giving hints for conducting them, and the information obtained. 1600 w. Mech Engr—Dec. 2, 1905. No. 73678 A.

Cylinders.

Calculating the Size of the Cylinders for a Multiple Expansion Engine. George Elfers. Illustrates, by example, the manner of solving this problem. 1700 w. Marine Engng—Jan., 1906. No. 74023 C.

Diagrams.

The Construction of Steam Diagrams (Konstruktion der Dampfdiagramme). Hr. Debye. An application of the investigations of Gütermuth upon the flow of steam through ports, to the study of the velocity of steam flow upon indicator diagrams. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 25, 1905. No. 73804 D.

Engines.

A Notable Mesta Corliss Engine. Illustrated detailed description of the 44 and 72 x 60 inch horizontal-vertical Corliss compound engine built for the Tennessee Coal, Iron & R. R. Co. 2000 w. Ir Age—Dec. 21, 1905. No. 73939.

Machinery at the New Royal Naval College, Dartmouth. Illustrates and describes a triple-expansion engine, with independent surface condenser, air and circulating pumps, and all necessary tanks, pipes, &c., installed for the purpose of instructing young officers in the practical working of the steam engine. 1000 w. Engr, Lond—Dec. 15, 1905. No. 74054 A.

Six-Cylinder Compound Engine (Machine à Vapeur Compound à Six Cylindres). An illustrated description of a rolling-mill reversing engine of 10,000 h. p. at the Cockerill works at Seraing, Belgium. 1500 w. 1 plate. Génie Civil—Nov. 25, 1905. No. 73812 D.

Exposition.

Steam Boilers and Engines at the Görlitz Industrial Exposition (Die Dampfkessel und Dampfmaschinen auf der Niederschlesischen Gewerbe und Industrie Ausstellung Görlitz 1905). Dr. Förster. An illustrated review, describing water-tube boilers, steam fittings, and engines of recent German design. 4000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 18, 1905. No. 73800 D.

Flanges.

High-Pressure Steam-Pipe Flanges. Franz Koester. Comments and description of types. Ills. 1700 w. Power—Dec., 1905. No. 73705 C.

Fuels.

Coal-Dust Firing. Eustace Carey. Abstract of a paper read at Liverpool before the Soc. of Chem. Ind. Reports the results that have been obtained with coal-dust firing, and the advantages. 1800 w. Eng & Min Jour—Dec. 16, 1905. No. 73773.

Comparative Heat-Producing Values of Different Fuels. Prof. Erasmus Haworth. Explains the method usually adopted for testing heat-producing qualities and gives results and general information. 3800 w. Pro Age—Dec. 15, 1905. No. 73759.

Crude Oil Burning. J. R. Collins. Points on the requirements for the successful use of this fuel. Ills. 800 w. Engr, U S A—Dec. 15, 1905. No. 73789 C.

Fuel Substitutes. Prof. Arthur Lakes. Some of the different materials utilized for burning in regions where ordinary

We supply copies of these articles. See page 799.

fuels are unattainable are discussed. Ills. 1400 w. Mines & Min—Dec., 1905. No. 73713 C.

The Utilization of Low Grade Fuels for Steam Generation. W. Francis Goodrich. The second and concluding paper deals with the adaptations of the boiler furnace and appliances to the satisfactory combustion of low-grade fuels. 3000 w. Engineering Magazine—Jan., 1905. No. 73893 B.

Governor.

The Tolli Spring Governor. Emile Guarini. Illustration with description of the operation of these governors. 800 w. Sci Am Sup—Dec. 2, 1905. No. 73557.

History.

The First Steam Engines out of England (Die Ersten Dampfmaschinen ausserhalb Englands). Conrad Matschoss. A review of early installations of Newcomen and Savery engines on the Continent, from 1715 to 1763, with illustration of a Newcomen engine built by Potter for the Königsberg coal mine in Hungary, in 1722. 3500 w. Zeitschr d Ver Deutscher Ing—Dec. 9, 1905. No. 73808 D.

Lubrication.

Steam Engine Lubrication. R. T. Strohm. Illustrates and describes the construction and operation of various lubricators, as applied to the steam engine, with the exception of those used in cylinder lubrication. 3000 w. Am Elect'n—Dec., 1905. No. 73562.

Pipe Coverings.

Value of Non-Conducting Coverings. William H. Fowler. Discusses the loss of heat which takes place in uncovered steam pipes, and the saving effected by non-conducting coverings. 1800 w. Mech Engr—Nov. 25, 1905. No. 73585 A.

Pressure.

Equalized Pressures. An explanation of the laws governing expansion and compression of gases, with diagrams. 1000 w. Ry & Loc Engng—Dec., 1905. No. 73526 C.

Smoke.

Conference of Smoke Abatement. Explains the objects and work of the Coal Smoke Abatement Society, and reviews the work of the conference held at Westminster. 7000 w. Engr, Lond—Dec. 15, 1905. No. 74056 A.

Steam Consumption.

The Steam Consumption of Piston Engines. T. Stevens and H. M. Hobart. Gives a table of the steam consumption of 33 piston-engines, with report of tests made. 1000 w. Power—Dec., 1905. No. 73704 C.

Steam Meter.

A Meter for Measuring the Flow of Steam (Dampfgeschwindigkeitsmesser). Describing the improved Gehre meter for measuring the velocity of steam in a pipe by taking the pressure on both sides of a contracted neck. 1500 w. Glückauf—Dec. 9, 1905. No. 73843 D.

Stokers.

Test of Shell Boilers Using the Roney Stoker. G. W. Baird. Report of a test made on the boilers of the Post-Office Department at Washington, D. C., to determine whether pea coal would furnish sufficient steam, its economic efficiency, and the quantity needed for a yearly supply. 900 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73951 H.

Superheating.

Properties of Superheated Steam. Prof. J. E. Denton. Reviews the results of investigations made by experimenters and the theories advanced and formulas deduced. 4000 w. Stevens Ind—Oct., 1905. No. 73926 D.

Superheated Steam and the Construction of Superheaters as Used in Power Plants. Franz Koester. Illustrations of types of superheaters, with a discussion of the use of superheated steam. 3500 w. St Ry Rev—Dec. 15, 1905. No. 73778 C.

Turbines.

A Broader Field for the Steam Turbine. Discusses the uses of the direct-connected continuous current turbine units. 1000 w. Eng News—Nov. 30, 1905. No. 73548.

Dimensions of Steam Turbines for Marine Work. E. M. Speakman. Read before the Inst. of Engrs. & Shipbuilders in Scotland. Discusses the steps necessary to determine the turbine efficiency and propeller efficiency, and the essentials for correct design. 2500 w. Mech Engr—Nov. 25, 1905. Serial. 1st part. No. 73588 A.

Notes on the Design of Reaction Turbines. Henry F. Schmidt. Explains the conditions peculiar to this type, discussing the principles of reaction, and the methods and calculations necessary. 5000 w. Power—Dec., 1905. No. 73709 C.

Pressures at the Various Stages of Multiple-Stage Steam Turbines. A. M. Levin. An explanation of a ready means for the solution of questions of this class. 1000 w. Power—Dec., 1905. No. 73703 C.

Test of a 500-Kilowatt Curtis Steam Turbine at Ottumwa, Iowa. John Wishart. An account of a test made to determine the performance of the turbine plant and to ascertain its satisfactory operation under guaranteed test conditions. 1700 w. Engr, U S A—Dec. 1, 1905. No. 73616 C.

The Allis-Chalmers Steam Turbine. Illustrated description of the turbine outfit

We supply copies of these articles. See page 799.

recently installed at Utica, N. Y. 1600 w. Ir Age—Dec. 14, 1905. No. 73722.

The Rateau Steam Turbine and Its Applications. M. J. Rey. A monograph of the steam-turbine created by Mr. Rateau; giving also a classification of the different systems of steam-turbines, and some historical facts regarding the invention. Ills. 24500 w. Jour Am Soc of Nav Engrs—Nov., 1905. No. 73947 H.

See also Marine and Naval Engineering.

Valve Gear.

Musgrave's Valve Gear for Steam Engines. Illustrates and describes an improved construction and arrangement for steam engines of the type in which the distribution is effected by four senarate balanced piston valves, two for admission and two for exhaust. 900 w. Mech Engr—Nov. 25, 1905. No. 73590 A.

Water Softening.

Notes on Water Softening. W. M. effect of neutral salts, the influence of the apparatus used, the determination of lime factor, and the soda factor, &c. 1700 w. Eng & Min Jour—Dec. 2, 1905. No. 73538.

MISCELLANY.

Aeronautics.

Recent Experiments in Aerial Navigation (Un Nouvel Essai de Navigation Aerienne). M. Léger. An illustrated description of the experiments with lifting screw-propellers, made by the author for the Prince of Monaco. 4000 w. Rev Gen des Sciences—Nov. 15, 1905. No. 73875 D.

Recent Experiments with the Lebaudy Balloon (Les Nouvelles Expériences du Lebaudy). Lt. Col. G. Espitallier. An illustrated account of the ascensions of the dirigible balloon of Lebaudy in 1904-1905, including the trip of 210 kilometres from Moisson to Mourmelon. 2000 w. Génie Civil—Dec. 9, 1905. No. 73815 D.

The Useful Coefficient of Screw Propellers (Sur le Coefficient d'Utilisation des Hélicoptères). Edgar Taffoureau. An examination of the best proportions of lifting screw propellers for use for aeronautical purposes, following the work of the late Col. Renard. 1200 w. Comptes Rendus—Nov. 27, 1905. No. 73830 D.

Engineering Building.

The Engineering Building. Illustrated description of the principal features of the fine building being erected in New York City, taken from a recently issued report. 1800 w. Ir Age—Dec. 14, 1905. No. 73719.

Liquid Air

The Liquefaction of Air (Liquéfaction de l'Air). Discussing especially the production of pure oxygen by fractional distillation of liquid air. 2500 w. Génie Civil—Dec. 9, 1905. No. 73817 D.

The Liquid Air Plant of the Chemistry Department, University of California. F. G. Cottrell. Illustrates and describes the plant and its operation, and the uses made of it. 4000 w. Cal Jour of Tech—Sept., 1905. No. 74077 C.

The Separation of Oxygen and Nitrogen by the Partial Liquefaction of Air (Sur l'Application de la Liquéfaction Partielle de l'Air avec Retour en Arrière à la Separation Intégrale de l'Air en Oxygene Pur el Azote Pur). Georges Claude. Describing the operation of a regenerative apparatus for the fractional separation of oxygen. 1200 w. Comptes Rendus—Nov. 20, 1905. No. 73828 D.

Progress.

Progress in Iron and in Mechanical Art. J. H. Wicksteel. Lecture at Leeds before the Assn. of Yorkshire Students. Discusses some improvements now in progress, and of recent date in the present number. 5000 w. Engr, Lond—Dec. 8, 1905. Serial. 1st part. No. 73913 A.

MINING AND METALLURGY

COAL AND COKE.

Coke.

Coke as a Blast-Furnace Fuel—Its Manufacture and Characteristic Properties. Edward A. Uehling. An illustrated article explaining the making of coke, the wastefulness of the beehive coke-ovens, and of the early methods used, and the better results obtained by retort ovens. 3000 w. Stevens Ind—Oct., 1905. No. 73928 D.

The Manufacture of Coke in Northern China. Yang Tsang Woo. Brief illustrated description of the coke-kilns and method used. 700 w. Am Inst of Min Engrs—Nov., 1905. No. 73965.

Coke Oven.

A New By-Product Coke-Oven. R. Schorr. Illustrated description of an oven specially designed to coke lean coals and also non-coking fuels with the addition of oil, oil residues, coal-tar, molasses, &c. 500 w. Eng & Min Jour—Dec. 16, 1905. No. 73774.

We supply copies of these articles. See page 799.

Coking.

The Progress of Coke Manufacture in the Saar District (Die Fortschritte der Koksfabrikation im Saargebiet). Oskar Simmersbach. An account of the operation of by-product coke ovens, with tabulated data of dimensions and performance. 3000 w. Stahl u Eisen—Dec. 1, 1905. No. 73850 D.

Model Plant.

A Model Illinois Coal Mining Plant. Charles H. Smith. Illustrated description of No. 8, a new mine plant at Clifford, Illinois. 2000 w. Min Wld—Dec. 23, 1905. No. 74005.

Philippines.

United States Enterprise in the Coal Trade of the Philippines. Oscar Halvorsen Reinholt. A review of the development of coal mining in the islands in connection with the United States government explorations. 4500 w. Engineering Magazine—Jan., 1906. No. 73891 B.

Washeries.

Anthracite-Washeries. George W. Harris. A discussion of the waste in the breaker, represented by the old culmbanks, and the steps taken to diminish it. 4000 w. Ills. Am Inst of Min Engrs—Nov., 1905. No. 73962.

West Virginia.

The Loup Creek Colliery Company. George W. Harris. An illustrated description of this mining property in West Virginia, the methods of mining, coke oven equipment, &c. 3800 w. Eng & Min Jour—Dec. 9, 1905. No. 73643.

COPPER.

Assay.

The Electrolytic Assay of Lead and Copper. George A. Guess. An illustrated description of the writer's method. 1500 w. Am Inst of Min Engrs—Nov., 1905. No. 73960.

Determination.

Notes on Technical Determination of Copper by the Cyanide Method. Irving Miller. Gives a few of the practical details of manipulation in connection with the cyanide assay of copper ores and products. 1200 w. Cal Jour of Tech—Dec., 1905. No. 74080 C.

Distillation.

The Distillation of Copper (Sur la Distillation du Cuivre). Henri Moissan. A discussion of the volatilization of copper in the electric furnace, and the nature of the condensed vapor. 2000 w. Comptes Rendus—Nov. 27, 1905. No. 73829 D.

Mines.

Britannia Copper Syndicates, Mines and Concentrating Works at Howe Sound, B. C. E. Jacobs. Illustrates and describes the mines, concentrating plant, &c., giving the history. 7500 w. B C Min Rec—Nov., 1905. No. 73737 B.

Ore Deposits.

Genesis of the Ore-Deposits at Bingham, Utah. J. M. Boutwell. A statement on the genesis of the copper- and lead-deposits, with conclusions. Ills. 12000 w. Am Inst of Min Engrs—Nov., 1905. No. 73956 D.

Precipitation.

Copper Precipitation Plants at Butte. An account of the commercial extraction of copper from mine and tailings seepage waters by the use of scrap iron and tin as precipitants. 2000 w. Min Rept—Dec. 21, 1905. No. 74009.

Refining.

Electrolytic Copper. Lawrence Addicks. Discusses the subject of the electrolytic refining of copper, especially from the point of view of the multiple system of refining. 4000 w. Jour Fr Inst—Dec., 1905. No. 73933 D.

Separation.

Improvements in Nickel-Copper Separation. Ambrose Monell describes an improvement in the method of separating nickel and copper sulphides, as practiced at the Oxford works. 1200 w. Eng & Min Jour—Dec. 16, 1905. No. 73770.

Smelting.

The Constitution of Mattes Produced in Copper-Smelting. Allan Gibb and R. C. Philp. Report of research work, both from a chemical and physical standpoint, of the constitution of mattes produced in copper smelting, the investigation involving both synthesis and analysis. 5200 w. Am Inst of Min Engrs—Nov., 1905. No. 73957 D.

GOLD AND SILVER.

Assaying.

Assaying Argentiferous-Tin-Copper Alloys. P. J. Thibault. Report of an unsuccessful attempt to apply the method used for the dry determination of silver in tin-lead alloys and metallic tin, to the alloys named. 700 w. Aust Min Stand—Nov. 15, 1905. No. 74083 B.

Some Assay Results on Resampled Ores. Howard C. Parmelee. Read before the W. Assn. of Tech., Chem. & Met. Gives tabulated statement of results, and deductions drawn. Also discussion. 3000 w. Min Jour—Dec. 2, 1905. No. 73684 A.

Australia.

Reduction Plant and Process at the Oroya-Brownhill Mines. Robert Allen. Abstract from *Jour. Cham. Mines*, Kalgoorlie, W. A. Describes the wet crushing process used and the treatment. 2200 w. Min & Sci Pr—Nov. 25, 1905. Serial. 1st part. No. 73510.

We supply copies of these articles. See page 799.

Black Sands.

Second Preliminary Report on Investigation of Black Sand. Information from the report of Dr. David T. Day concerning the experiments in concentration which have been conducted at the Lewis & Clark Centennial Exposition, with a view of ascertaining the most economical method of separation. 1500 w. Min Rept —Dec. 7, 1905. No. 73663.

Cobalt.

Cobalt Mining District, Ontario. W. O. Hotchkiss. Map, and illustrated account of this rich cobalt-silver district and its development. 3000 w. Min Wld —Dec. 9, 1905. No. 73658.

Concentrates.

The Cyanidation of Concentrates. Bernard Macdonald. A statement of the commercial results, reporting tests made. 1800 w. Eng & Min Jour—Dec. 23, 1905. Serial. 1st part. No. 73995.

Cost-Accounts.

Cost-Accounts of Gold-Mining Operations. Thomas H. Sheldon. A detailed description of the system used by the Portland Gold Mining Co., Cripple Creek, Colo. 6500 w. Am Inst of Min Engrs—Nov., 1905. No. 73964 D.

Cripple Creek.

Resurvey of Cripple Creek District, Colorado, by the United States Geological Survey. Abstract of report showing new facts determined. 3000 w. Mines & Min—Dec., 1905. No. 73718 C.

Dredging.

Gold Dredging in Colombia. J. P. Hutchins. An account of a recent examination of the deposits on the Magdalena river and its affluents, with conclusions as to dredging probabilities. 3000 w. Eng & Min Jour—Dec. 2, 1905. No. 73533.

Gold Dredges. F. F. Coleman. Describes the general character of the dredge, and the work it is to do, illustrating types, and explaining the kind of work for which each is adapted. 2000 w. Marine Engng—Jan., 1906. No. 74021 C.

Goldfields.

The Northern Goldfields of Colorado. John A. Wolff. Gives the history of this region, describing the deposits, and giving opinion of their great value. 1800 w. Min Wld—Dec. 16, 1905. No. 73782.

Grinding.

Fine Grinding in Metallurgy. E. E. Wann. Aims to open a discussion of the method of extraction by amalgamation and cyanide leaching of gold ores, with a view to improving the treatment of slimes, and constructing a regrinding device superior to those in use. 2000 w. Min & Sci Pr—Dec. 16, 1905. No. 74010.

New Mines.

Notes on Southern Nevada and Inyo County, California. H. H. Taft. Information concerning the volcanic area, the Bullfrog mining district, Tonopah, Goldfield, Death Valley, and surrounding regions. 8500 w. Am Inst of Min Engrs —Nov., 1905. No. 73963 C.

Parting Methods.

Electrolytic Versus Sulphuric Parting of Bullion. F. D. Easterbrooks. Abstract of a paper before the Am. Elec.-Chem. Soc., pointing out some of the principal characteristics of the several parting methods. 1600 w. Eng & Min Jour—Dec. 16, 1905. No. 73771.

Sampling.

Notes on Stope Box Sampling. Wager Bradford. An account of the system of daily stope box sampling as carried out at Langlaate Deep. 3800 w. Jour of Chem, Met, and Min Soc of S Africa—Oct., 1905. No. 73966 E.

Solubility.

The Solubility of Gold in Thiosulphates and Thiocyanates. H. A. White. A report of experiments made to determine the cause of the presence of gold in certain mine reservoirs and the enrichment of soil underneath some residue dumps. 1700 w. Jour of Chem, Met, and Min Soc of S Africa—Oct., 1905. No. 73967 E.

Slimes.

The Buss Slimer. A new slime table, invented by Dr. Julius Buss, is illustrated and described. It is intended for treating any ore or tailing between 50-mesh linear and the finest powder that settles in water. 600 w. Eng & Min Jour—Dec. 16, 1905. No. 73769.

Sulphur.

Sulphur in Roasting. William E. Greenawalt. Discusses the elimination of sulphur in roasting ores, and the determination of the sulphur that will give the best results. 1900 w. Eng & Min Jour—Dec. 23, 1905. No. 73996.

IRON AND STEEL.

Basic Process.

The Direct Charging of the Open-Hearth Basic Furnace from the Blast Furnace (Ueber die Verarbeitung Flüssigen Roheisens im Basisch Zugestellten Martinofen). C. Dichmann. A discussion of the practicability of using direct melted charges of raw iron into the basic open-hearth furnace. Serial. Part I. Stahl u Eisen, Dec. 1, 1905. No. 73849 D.

Concentration.

Notes on Some Recent Experiments on the Magnetic Concentration of Iron Sands from the Lower St. Lawrence. John F. Robertson. Deals with attempts to cheap-

We supply copies of these articles. See page 799.

ly overcome the low percentage of iron, and the presence of titanium. Ills. 1600 w. Can Soc of Civ Engrs—Nov. 30, 1905. (Adv. proof.) No. 74087 C.

Furnace Hoist.

Electric Furnace Hoist. L. Ramakers. An illustrated description of an electrically-operated furnace hoist, which was recently constructed at Frankfurt, Germany. 1200 w. Elec Wld & Engr—Dec. 9, 1905. No. 73669.

Iron Industry.

See Industrial Economy.

Iron Works.

The Lothringer Iron Works at Kneuttingen (Die Werke des Lotringer Hüttenvereins in Kneuttingen). Bernhard Osann. A detailed description of the furnaces and rolling mills of a new large works in Belgian Lorraine. 4500 w. Three plates. Stahl u Eisen—Nov. 15, 1905. No. 73847 D.

Ore Deposits.

The Iron Ore Deposits of the World (Die Eisenerzvorräte der Welt). A statistical review, giving brief tables of the principal deposits of iron ore in Europe and America. 2000 w. Glückauf—Dec. 9, 1905. No. 73844 D.

The Menominee Range. John L. Buell. Abstract of a paper read before the Lake Superior Min. Inst. Gives some reasons why the discovery of these iron ore deposits were belated, an account of the discovery, and theeories of the formation. 1500 w. Ir Age—Dec. 7, 1905. No. 73581.

The Origin of Clinton Red Fossil-Ore in Lookout Mountain, Alabama. William M. Bowron. Gives the theory advanced to explain these deposits, personal investigations, a statement of the geological conditions, conclusions, &c. Ills. 6500 w. Am Inst of Min Engrs—Nov., 1905. No. 73961.

See Industrial Economy.

Rail Mill.

Plant of the Algoma Steel Co., Sault Ste. Marie. Illustrates and describes one of the most modern steel plants in Canada. The principal production is steel rails. 3500 w. Ir Trd Rev—Dec. 21, 1905. No. 73974.

MINING.

Accidents.

Fatal Accidents in Coal Mining in 1904. Frederick L. Hoffman. A report of the facts with comment on the causes and conditions. 3500 w. Eng & Min Jour—Dec. 2, 1905. No. 73535.

Electric Power.

Electricity as Applied to Mining. W. C. Mountain. The first of three lectures on this subject, to be given at the University College, Nottingham. A record of progress made in the application of electricity to coal mines, and suggestions for future applications. Ills. 7500 w. Ir & Coal Trds Rev—Dec. 1, 1905. No. 73686 A.

Electricity vs. Compressed Air for Mine Operations. Two papers on this subject are given. W. R. Hulbert discusses it from the electrical point of view; and Edward F. Schaefer from the compressed air point of view. 2800 w. Compressed Air—Dec., 1905. No. 73999.

Improvements in Electric Power for Mining Plants (Neuerungen bei Elektrischen Anlagen im Bergwerks und Hüttenbetrieb). Hr. Philippi. Comparing the Leonard and the Ilgner systems of regulation as applied to electric hoisting engines. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 18, 1905. No. 73801 D.

Explosion.

The Wattstown Colliery Explosion. Notes on the disaster that occurred July 11, 1905, by James Ashworth, and an official report. 9000 w. Ir & Coal Trds Rev—Dec. 1, 1905. No. 73685 A.

Faults.

An Interesting Fault-System. C. G. Gunther. Brief description, with vertical section, of an unusual system opened up in the New York mine, in Siskeyou county. 400 w. Eng & Min Jour—Dec. 2, 1905. No. 73534.

Hoisting.

A Bucket Elevator Installation for a 155-Ft. Zinc Mine Shaft. Illustrated description of a continuous bucket elevator installed at Carthage, Mo., to raise zinc ore from an inclined shaft. 600 w. Eng News—Dec. 7, 1905. No. 73625.

A Novel Water Hoist. Illustrates and describes the electric automatic arrangement for hoisting water at the Hampton-Central water shaft of the D. L. & W. R. R. Co. 1400 w. Mines & Min—Dec., 1905. No. 73715 C.

Electricity in Continental Mines. C. Smith. Illustrated description of some German hoisting plants having interesting features. 3500 w. Mines & Min—Dec., 1905. No. 73714 C.

Mine Hoisting with Driving Sheaves (Die Förderung mit Treibscheibe). H. Baumann. A review of the Koepe system of winding, using driving sheaves instead of drums, showing its application to deep shafts. 2000 w. Glückauf—Nov. 25, 1905. No. 73841 D.

The Aerial Rail Hoist and Haulage System. W. R. Crane. Illustrated description of apparatus recently installed for raising and transporting ore in the Joplin region. 2000 w. Mines & Min—Dec., 1905. No. 73712 C.

We supply copies of these articles. See page 799.

Launders.

Sand Launders. Thomas T. Read. Information regarding the use of launders for the movement of solid material in water currents. 900 w. Eng & Min Jour —Dec. 16, 1905. No. 73775.

Mine Examination.

The Examination of Mines Preliminary to Purchase: To-day as Compared with Twenty-five Years Ago. R. Gilman Brown. Read before the Am. Min. Cong. A paper containing information of value to engineers, students, miners, and the general public. 3500 w. Min & Sci Pr—Nov. 25, 1905. No. 73509.

Mining Debris.

Control of Hydraulic Mining Débris in California by the Federal Government. Capt. Wm. W. Harts. Read before the Mining Conference. Explains the problem, the extent of the damage, discussing the duties of the commission, and the general principles of improvement. Ills. 6000 w. Cal Jour of Tech—Sept., 1905. No. 74079 C.

Ontario.

Some Timiskaming Ores. Phillips Thompson. Information from a paper by Prof. W. G. Miller concerning the silver-cobalt-nickel-arsenic ores of northern Ontario. 1800 w. Map. Eng & Min Jour —Dec. 2, 1905. No. 73537.

Ore Deposits.

Some of the Veins and Ore Deposits of the Wood River District, Idaho. Arthur Lakes. Describes the occurrence and mode of vein formation and ore deposition in this region. 2000 w. Min Wld —Dec. 23, 1905. No. 74007.

The Limestone-Granite Contact-Deposits of Washington Camp, Arizona. W. O. Crosby. A discussion of the general geology, the ore deposits, the metamorphism of the limestone and chert, &c. 9000 w. Am Inst of Min Engrs—Nov., 1905. No. 73959 C.

Theories of Ore Deposition Historically Considered. S. F. Emmons. Address befor the Geol. Soc. of America, at St. Louis. Gives the opinions held on this subject which have most impressed the minds of geologists. 3500 w. Sci Am Sup—Dec. 16, 1905. Serial. 1st part. No. 73730.

Respiration Apparatus.

A New Respiration Apparatus. A brief description of the two present forms of the Bamberger-Böck pneumatogen. Ills. 1400 w. Sci Am Sup—Dec. 23, 1905. No. 73988.

Rock Drills.

Improved Electric Rock Drills (Neuere Elektrische Stossbohrmaschinen). W. Wolf. Describing improved forms of solenoid rock drills, with details of construction. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 18, 1905. No. 73846 D.

Notes on the Construction and Practical Operation of Rock-Drilling Machines. Lengthy discussion of E. M. Weston's paper on this subject. 13000 w. Jour of Chem, Met & Min Soc of S Africa —Oct., 1905. No. 73968 E.

Sand Pumping.

A New Method of Pumping Sand by Means of Compressed Air at the Plant of the United States Silica Co. Lucius I. Wightman. Illustrated description of an installation at Ottawa, Ill., especially adapted for this work. 1200 w. Eng News—Dec. 7, 1905. No. 73622.

Shafts.

Modern Methods in Shaft Sinking. James Tonge. An illustrated account of some recent improvements in shaft-sinking methods in Great Britain. 2500 w. Mines & Min—Dec., 1905. No. 73717 C.

Shaft Guides. Bergassessor Ackermann, in *Zeit. Berg-, Hütten- und Salinenwesen.* Gives experience gained with various kinds of shaft guides in the Breslau Mining District. Ills. 9000 w. Col Guard—Dec. 15, 1905. No. 74051 A.

Some Considerations in the Equipment of Incline Shafts. F. N. Hambly. Discusses the size and grade of shaft, headgear bins, skips, tracks, and ore bins underground. 4000 w. Jour S African Assn of Engrs—Oct., 1905. No. 74039 F.

Shot-Firing.

Safe Shot-Firing in Coal Mines. George G. André. Briefly considers the quantity of explosive used, slow firing, firing by electricity, &c. 1200 w. Col Guard—Dec. 15, 1905. No. 74050 A.

Signals.

Electric-Optical, Acoustic Signals at the Julius III. Shaft at Brüx (Elektrisch, Optisch, Akustische Seilbahn Signalanlage am k. k. Schachte Julius III. in Brüx). Gustav Ryba. Describing a signal system for use in connection with an underground cable traction haulage installation. Two articles. 4000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 18, 25, 1905. No. 73845 each D.

Tropics.

Life and Mining in the Tropics. G. M. Colvocoresses. Considers the climate and its influence, and gives suggestions for keeping in good health. 3000 w. Eng & Min Jour—Dec. 23, 1905. No. 73993.

Veins.

The Origin of Vein-Filled Openings in Southeastern Alaska. Arthur C. Spencer. To account for certain features observed in the Juneau gold-belt in Alaska, the

paper indicates in detail certain conditions in which deformation of rocks under their own weight might lead to the production of fractures in which veins could be deposited. Ills. 1500 w. Am Inst of Min Engrs—Nov., 1905. No. 73958.

Water Supplies.

The Importance of Potable Water Supplies to Mining Communities. Charles E. Morrison. Discusses the usual sources of supply for mining camps, and the dangers of some of them. 1500 w. Eng & Min Jour—Dec. 9, 1905. No. 73642.

MISCELLANY.

Lead.

Lead Smelting in Reverberatory Furnaces at Desloge, Mo. W. R. Ingalls. Describes the technical results of furnaces of the Flintshire type at Desloge. 2200 w. Eng & Min Jour—Dec. 16, 1905. No. 73772.

The Savelsberg Process. W. R. Ingalls. Outlines this process for the desulphurization of galena by lime-roasting. 2200 w. Eng & Min Jour—Dec. 9, 1905. No. 73645.

Mineral Industry.

See Industrial Economy.

Natural Gas.

The Transportation of Natural Gas. D. S. Ferry. Illustrates and describes the feeders from the largest gas well, in West Virginia, and the great gas engines at Hastings. 1200 w. Power—Dec., 1905. No. 73701 C.

Petroleum.

The Oil Fields of the West. Day Allen Willey. An illustrated account of the development of the oil-bearing sands west of the Mississippi River. 1800 w. Sci Am—Dec. 16, 1905. No. 73726.

Platinum.

Assay of the Platinum Metals. From *Oest. Zeit. f. Berg- und Hüttenwesen.* A description, by Dr. Nordenskjöld, of some analyses which do not appear to be well known, and which are more rapid than and milling practice. 3500 w. Eng & Min Jour—Dec. 2, 1905. No. 73536.

Progress.

Recent Progress in Metallurgy. A. E. Outerbridge, Jr. Address, reviewing briefly the field covered by the metallurgical industries and the progress during the past year. 7500 w. Jour Fr Inst—Dec., 1905. No. 73932 D.

Talc.

Talc in Northern New York. Robert B. Brinsmade. An illustrated description of the deposits of the Talcville region, discussing their origin, and the mining and milling practice. 3500 w. Eng & Min Jour—Dec. 23, 1905. No. 74994.

Zinc.

The Electrometallurgy of Zinc (Zur Elektrometallurgie des Zinks). Dr. Franz Peters. A general review of progress in the electrolytic separation of zinc during the past five years. Serial. Part I. 4000 w. Glückauf—Dec. 2, 1905. No. 73842 D.

The Zinc Industry of the Rocky Mountain Region. W. G. Swart. Read before the Am. Min. Cong. An account of the processes used for removing the impurities and the methods of successfully handling these low-grade ores. 1800 w. Eng & Min Jour—Dec. 9, 1905. No. 73644.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Injuries to Passengers. Calls attention to the causes of many accidents, showing how they could be prevented. 4000 w. R R Gaz—Vol. XXXIX., No. 24. No. 73741.

Cuba.

Railroading in Cuba. Relates incidents in regard to travel on Cuban railways, both humorous and exasperating. 2500 w. Ry & Engng Rev—Dec. 16, 1905. No. 73786.

End Shocks.

End Shocks in Car Service and Provision for Same in Car Framing. A. Stucki. Indicates the conditions which cars should be required to meet and which could be used as a basis for handling the cars. 7200 w. Pro Ry Club of Pittsburgh—Sept., 1905. No. 73757 C.

Southern Roads.

The Southern Roads and the Territory They Serve. W. D. Taylor. Describes the conditions which have been the cause of slow railroad development in the South, and the present conditions, with information concerning the lines which control most of the southern traffic. 4200 w. Ry Age—Dec. 8, 1905. No. 73661.

MOTIVE POWER AND EQUIPMENT.

Cars.

Baggage Car for Automobiles. Brief illustrated article showing the construction.

400 w. Am Engr & R R Jour—Dec., 1905. No. 73530 C.

Construction of a Passenger Car. C. F. Rydberg. Read before the Canadian Ry. Club. A general discussion of the more important points in the construction. 5000 w. Ry & Engng Rev—Dec. 2, 1905. No. 73502.

Fire-Boxes.

Early Experiments with Smoke-Consuming Fire-Boxes on American Locomotives. C. H. Caruthers. An interesting illustrated review of types of boilers, fireboxes, &c., brought out between 1857 and 1859 aiming to consume the smoke and gases of bituminous coal. 2500 w. R R Gaz—Vol. XXXIX., No. 22. No. 73545.

Locomotives.

Baltimore and Ohio Consolidation Locomotive. Illustrated descriptions of locomotives from special designs, 210 of which are being built. An account of the requirements to be met is also given. 1700 w. Ry Age—Dec. 22, 1905. No. 73991.

Comparative Magnitude of Longitudinal Disturbing Forces in a Cole Balanced Compound and a Single Expansion Express Locomotive. Edward L. Coster. Gives an analysis of the relative horizontal inertia effects. 800 w. Am Engr & R R Jour—Dec., 1905. No. 73531 C.

Consolidation Locomotive for the Baltimore & Ohio Railroad. Gives particulars of interest regarding these engines. 1500 w. R R Gaz—Vol. XXXIX., No. 24. No. 73740.

Electric vs. Steam Locomotives. R. H. Probert. Read before the Ohio Soc. of Elec., Mech., and Steam Engrs. Considers a general example showing the lower cost of operation and other advantages from electrical equipment. 4500 w. Engr, U S A—Dec. 1, 1905. No. 73621 C.

Four-Coupled Express Locomotive for the Belgian State Railways. H. W. Hanbury. Illustration with description of an engine for express passenger service, of simple type with inside cylinders and Stephenson motion. 800 w. Engng—Dec. 1, 1905. No. 73689 A.

Four-Cylinder Compound Locomotive for the Paris, Lyons, and Mediterranean Railway. H. W. Hanbury. Illustrated detailed description of a six-coupled locomotive believed capable of maintaining an average speed of 50 miles per hour on varying gradients, with a load of 300 tons. 1500 w. Engng—Nov. 24, 1905. No. 73604 A.

German Compound Locomotive with Superheater. Illustrates an interesting type of high-speed locomotive, giving brief description. 300 w. Ry Age—Dec. 1, 1905. No. 73507.

Goods Locomotives on British Railways. Charles S. Lake. The practice of recent years in England is illustrated and described. 1600 w. Mech Engr—Dec. 9, 1905. Serial. 1st part. No. 73900 A.

Lackawanna Eight-Wheel Passenger Locomotives with Superheater. The engine 955 equipped with Cole superheater, with piston valves, is illustrated and described. 500 w. Ry Age—Dec. 15, 1905. No. 73780.

Locomotives of the Belgian State Railway at the Liége Exhibition. F. Matthei. Illustrations, descriptions of types, and general remarks. 9400 w. Table. Bul Int Ry Cong—Nov., 1905. No. 73752 E.

Newest Caledonian Engines and Their Work. Charles Rous-Marten. Describes in detail the latest engines of the Caledonian Railway, and some of the work done by them. 4300 w. Engr, Lond—Dec. 8, 1905. No. 73909 A.

Pacific Balanced Compound for the Santa Fé. Illustrated description of a large passenger engine with four compound cylinders and Vauclain's engine arrangement. 300 w. Ry Age—Dec. 8, 1905. No. 73660.

Panama Canal Engines. Illustrated description of a 2-6-4 type of engine to be used in the construction of the canal. 144 are to be built. 700 w. Ry & Loc Engng—Dec., 1905. No. 73524 C.

Ten-Wheel Coupled Locomotive for the Great Western Railway of Argentina. Illustrations showing the general appearance and leading dimensions of an experimental locomotive to meet special conditions. 200 w. Engng—Nov. 24, 1905. No. 73601 A.

Ten-Wheeled (4-6-0) Locomotive for the New York Central & Hudson River. Illustrates and describes this type of locomotive, fifteen of which have been recently built for fast freight and heavy passenger service on the road named. 800 w. R R Gaz—Vol. XXXIX., No. 24. No. 73739.

The Capacity of Locomoives at Various Speeds (Ueber die Bestimmung der Leistungen von Lokomotiven aus dem Verlaufe der Geschwindigkeitskurven). Karl Schlöss. A study of the tractive power of locomotives based upon the performance at various points in the speed curve. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 24, 1905. No. 73822 D.

The Compound Locomotive of To-day. J. F. Gairns. The present article is introductory and reviews the position occupied by the compound locomotive to-day. The principal systems in use will be considered. 2000 w. Prac Engr—Dec. 15, 1905. Serial. 1st part. No. 74041 A.

The Evolution and Development of the Steam Locomotive as Evidenced by the Exhibits in the Transportation Building

We supply copies of these articles. See page 799.

at the St. Louis World's Fair. William A. Doble. Read before the Pacific Coast Ry. Club. An interesting illustrated review. 7800 w. Jour of Elec—Dec., 1905. Serial. 1st part. No. 73656 C.

The New Ten-Wheeled Express Locomotives of the Bavarian State Railways. E. Weiss. Gives a statement of the performances demanded, general arrangement and chief dimensions, with illustrated description. 2800 w. Bul Int Ry Cong—Nov., 1905. No. 73754 E.

The Origin of Four-Cylinder Balanced Compound Locomotives. Charles R. King. A review of designs of four-cylinder engines, and of balanced compounds, aiming to trace the first four-cylinder balanced compounds built. Ills. 4500 w. R R Gaz—Vol. XXXIX., No. 23. No. 73653.

The Recent Development of the Locomotive Engine. Calls attention to certain points in recent development, and the fact that the performance, economies and wastes cannot be treated on any basis of comparison drawn from the performance of stationary or marine engines. 3500 w. Engr, Lond—Dec. 1, 1905. No. 73691 A.

Motor Coaches.

Recent Developments in Motor Coaches Upon British Railroads. Illustrates and describes some recent types, especially the Peebles Steam Car. 2000 w. Sci Am Sup—Dec. 2, 1905. No. 73555.

Train Heating.

The Heating of Railway Trains (Heizung der Eisenbahnwagen). E. Ritt. Illustrated details of steam heating apparatus as used in German railway trains. 1800 w. Gesundheits-Ingenieur—Nov. 10, 1905. No. 73876 B.

Train Lighting.

The L'Hoest and Pieper System of Electric Train Lighting (Die Elektrische Zugbeleuchtung von L'Hoest und Pieper). E. Wikander. A steam-driven generating set is mounted on the locomotive boiler, the current being regulated on each car, and a small storage battery supplying current for three hours in case of detachment. 1800 w. Elektrotech Zeitschr—Nov. 16, 1905. No. 73852 B.

The L'Hoest-Pieper System of Train Lighting. Describes this system which aims to eliminate the axle-driven generator, and to reduce the equipment of each car to a small battery just sufficient for lighting the car in case it is disconnected from the locomotive. 800 w. Elec Wld & Engr—Dec. 2, 1905. No. 73614.

The Mixed System of Electric Train Lighting (Elektrische Beleuchtung von Personenwagen nach dem Gemischten Betrieb). Emil Dick. A comparison of the use of storage batteries and of the mixed system of dynamo and storage battery for the lighting of passenger trains. 4000 w. Zeitschr f Elektrotechnik—Nov. 26, 1905. No. 73863 B.

Valve Gear.

Walschaert Valve Gear. Max Pfander. Diagram and description, with a statement of its advantages as compared with ordinary link motion. 2000 w. Ry & Loc Engng—Dec., 1905. No. 73523 C.

Valves.

Westinghouse Improved Brake Valves. Gives views of the automatic and straight air brake valves and an explanation of how they should be handled while operating the brakes. 500 w. Ry & Loc Engng—Dec., 1905. No. 73525 C.

NEW PROJECTS.

Cut-Off.

The Low Grade Freight Cut-Off of the Pennsylvania R. R. Illustrates and describes the construction of a low-grade double-track freight line in Southeastern Pennsylvania, which involved some of the heaviest railroad work ever undertaken in the United States. 4000 w. Eng Rec—Dec. 16, 1905. Serial. 1st part. No. 73916.

The Pennsylvania Railroad Low Grade Freight Line from Harrisburg to Atglen, Pa. Explains the purpose and character of this work, giving an illustrated description of important railway grading, with very heavy work on a small portion of the line. 3500 w. Eng News—Dec. 28, 1905. No. 74030.

Japan.

Railroad Development in Japan. George E. Walsh. An account of present development and future outlook which seem to indicate a great awakening. 1500 w. R R Gaz—Vol. XXXIX., No. 23. No. 73654.

New Roads.

The Missouri, Oklahoma & Gulf Railway. Illustrates and describes a road under construction, discussing its traffic possibilities, ownership of real estate and the changed conditions, &c. 2400 w. Ry Age—Dec. 15, 1905. No. 73779.

PERMANENT WAY AND BUILDINGS.

Car House.

The Federal Street Car House of the Rochester Railway Company. I. E. Matthews. Gives plans and description of a building large enough to hold about 100 double-truck cars. 1600 w. St Ry Jour—Dec. 2, 1905. No. 73521 C.

Cologne.

The Transformation of the Railway Facilities about Cologne (Ueber die Umgestaltung der Bahnanlagen bei Köln). H. Kumbier. Describing the importance

We supply copies of these articles. See page 799.

of Cologne as a railway centre, with especial reference to the new passenger stations. 3500 w. Glasers Annalen—Nov. 15, 1905. No. 73818 D.

Curves.

The Determination of Curve Deflections and Rail Joints (Beitrag zur Lehre von der Berechnung der Bogenweichen und Geleisverbindungen). A mathematical discussion of the laying out of railway curves and junctions. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 1. 1905. No. 73824 D.

Freight Station.

New Freight Station at Cincinnati, O.; Cincinnati Southern Ry. Illustrated description, with statement of the requirements as given in the specifications. 1000 w. Eng News—Dec. 7, 1905. No. 73623.

Improvements.

New York Central Roadbed Improvements in the Vicinity of New York City. Illustrates and describes improvements made north of Mott Haven, including additional tracks, tunnels, new roadbed, cut-offs, depression, &c. 1600 w. Ry & Engng Rev—Dec. 16, 1905. No. 73784.

Some Money Saving Schemes, Minneapolis & St. Louis R. R. Brief descriptions of devices for saving labor in shops and tending to economy. A tool for truing wrist pins; a tool for threading radical stays, having button heads; a device for facing off the joints on cinder hoppers; and other tools and methods are described. Ills. 1500 w. Ry Mas Mech —Dec., 1905. No. 73500.

Rock Island.

Rock Island Company. An outline of the various lines composing this system with information from recent reports concerning the operation, earnings, &c. 2800 w. R R Gaz—Vol. XXXIX., No. 22. No. 73541.

Shops.

Locomotive Works, and Shop Practice in Italy. The present number is principally a description of the "Elvetica" works of The Ernesto Breda Company, of Milan, and the methods used there. Ills. 4400 w. Engr, Lond—Dec. 15, 1905. Serial. 1st part. No. 74055 A.

The Kingsland Shops of the Lackawanna R. R. These coach and locomotive shops in New Jersey are illustrated and described. They will cover an area of 8.5 acres, and will cost $1,000,000 when completed and equipped. 3500 w. Eng Rec—Dec. 2, 1905. No. 73574.

Winnipeg Shops of the Canadian Pacific. Illustrates and describes large modern shops for repair work. 1000 w. R R Gaz—Vol. XXXIX., No. 26. No. 74084.

Signaling.

A Cheap Method of Interlocking Switches and Signals. P. Grade. Describes a system of interlocking without placing the levers together in one cabin, or having to carry keys about. Gives applications, trials, and statement of advantages and cost. 3400 w. Ills. Bul Int Ry Cong—Nov., 1905. No. 73753 E.

The Upward Indication of the Semaphore Arm. L. R. Clausen. Reviews the history of this method of signaling, and discusses the question of changing from the downward to the upward indication for proceed, giving arguments in favor of the change. Ills. 2000 w. Wis Engr—Dec., 1905. No. 73751 D.

Terminals.

A Highland Railway Terminus. Brief illustrated description of the picturesque terminals of the Oban Railway, at Oban, Scotland. 400 w. Ry & Loc Engng—Dec., 1905. No. 73522 C.

Blair Furnace Freight Locomotive Terminal, Pennsylvania R. R. Illustrated description of a large locomotive terminal recently put into operation. 1500 w. Ry & Engng Rev—Dec. 23, 1905. No. 74001.

The Washington Terminal. Theodore Starrett. An illustrated description of this beautiful terminal station in process of construction. 1800 w. Arch Rec—Dec., 1905. No. 73609 C.

Tracks.

Effect of Rolling Stock on Track. Hugh Steele. Read before the New England R. R. Club. Discusses damage done by worn wheels, trailing obstructions from trains, water, &c., especially in large yards and terminals. 1300 w. Ry & Engng Rev —Dec. 16, 1905. No. 73785.

Kansas City-Topeka Double Track Work of the Union Pacific. An illustrated account of improvements amounting practically to rebuilding the line between the cities named. 3000 w. R R Gaz—Vol. XXXIX., No. 23. No. 73652.

The Evolution of Railway Track (L'Evolution des Voies de Chemins de Fer). M. Mesnager. An examination of the deformation of rails and joints under the action of high-speed trains. 1800 w. Génie Civil—Dec. 9, 1905. No. 73816 D.

Track Construction with Steel Longitudinals on the Pennsylvania R. R. Gives illustrations showing a construction that is to be tried which is a remarkable departure from the systems in use. It is the invention of Gustav Lindenthal. Also editorial. 1600 w. Eng News—Nov. 30, 1905. No. 73551.

Water Station.

The Water Supply Plant at the Speldorf Station (Die Wasserversorgungsanlage auf Bahnhof Speldorf). S. Lamm.

We supply copies of these articles. See page 799.

Details of the water tower and pumping plant for locomotive supply at the Speldorf division station on the Essen line of the Westphalian railways near Duisburg. Serial. Part I. 1000 w. Glasers Annalen —Nov. 15, 1905. No. 73819 D.

Yards.

New Freight Yard at Alexandria, Va., for the Washington Southern Ry. and the Richmond, Fredericksburg & Potomac R. R. W. A. MacCart. Plan and profile with descriptive notes. 1200 w. Eng News—Nov. 30, 1905. No. 73553.

TRAFFIC.

Accounting.

Underlying Principles and General Practices of Railway Accounting Departments. From a lecture by J. L. Burgess, at the Iowa State College. Considers the importance of the accounting department, the duties of accounting officers, the methods, &c. 3000 w. Ry & Engng Rev—Dec. 23, 1905. Serial. 1st part. No. 74000.

Development.

Union Pacific. Maps and review of the annual statement of this road, with editorial on the policy of main line development and the extension of branch lines. 5500 w. R R Gaz—Vol. XXXIX., No. 24. No. 73738.

Industrial Commissioner.

The Industrial Department. A review of the history of the railroad industrial department, with editorial on the work of the industrial commissioner. 5800 w. R R Gaz—Vol. XXXIX., No. 25. No. 74013.

Loading.

Classification of Locomotives for Tonnage Rating Purposes. J. H. Lonie. Explains a method of classification used on the Rock Island System. 1000 w. Am Engr & R R Jour—Dec., 1905. No. 73529 C.

Rate Regulation.

The President on Rate Regulation. Condensed abstract of the portion of the President's message which treats of railroad rate regulation. 2000 w. R R Gaz —Vol. XXXIX., No. 23. No. 73651.

Tonnage.

The Coal Carriers. Frederick E. Saward. Shows the importance of tonnage to the railroads, giving some idea of the annual haulage, especially from the coal territory. 2200 w. R R Gaz—Vol. XXXIX., No. 23. No. 73650.

STREET AND ELECTRIC RAILWAYS

Acceleration.

An Electric Accelerometer. B. B. Owens. Describes a simple and reliable method of measuring acceleration of a railway car or other machine. Ills. 600 w. Can Soc of Civ Engrs—Nov. 2, 1905. No. 73745 D.

Belfast.

The Belfast City Tramways. Information of interest concerning these recently completed lines, with plans and sections of the generating station. 6800 w. Elect'n, Lond—Dec. 1, 1905. No. 73682 A.

Construction.

Construction Work on the Rochester, Syracuse and Eastern Railroad. Explains the plan of construction of a road designed ultimately to furnish a double-track, high-speed, interurban electric road between Syracuse and Rochester. Ills. 3800 w. St Ry Jour—Dec. 16, 1905. No. 73790 C.

Direct Current.

A New and Higher Standard of D. C. Operation. Frank J. Sprague. The New York Central-New Haven Situation. Charles A. Mudge. Two letters on heavy electric railway work, with editorial discussion of them. 3000 w. St Ry Jour—Dec. 23, 1905. No. 74003 C.

Drainage.

Drainage of the Interborough Rapid Transit Railroad Under the Harlem River. An illustrated article explaining the drainage and pumping system adopted, and the precautions taken to meet possible conditions in the two tubes under the Harlem River. 1000 w. Stevens Ind—Oct., 1905. No. 73931 D.

Electric Traction.

The New York, Westchester & Boston Railway. Information concerning a four-track suburban electric line under construction on a right-of-way 100-ft. wide. Ills. 3000 w. Eng Rec—Dec. 2, 1905. No. 73570.

Electrification.

First Electrical Operation on the West Shore Railroad. Illustrates and describes the section between Frankfort and Herkimer, 3.17 miles long, used by steam trains of the West Shore R. R., and also by electric cars of the Utica & Mohawk Valley Ry. 1000 w. St Ry Jour—Dec. 16, 1905. No. 73792 C.

The Electrification of the New York

We supply copies of these articles. See page 799.

Central's Terminal Lines. An illustrated article summarizing the important work of electrifying the terminal lines of this railway. 6500 w. Sci Am Sup—Dec. 9, 1905. No. 73633.

Falkirk.

Falkirk Electric Tramways. Illustrated detailed description of overhead construction, following standard tramway practice for a moderately dense service. 2000 w. Tram & Ry Wld—Dec. 7, 1905. No. 73972 B.

Fire Hazard.

The Fire Hazard in Car Barns. Joseph B. Finnegan. Discusses the proper construction, the hazards due to repair work, heating and lighting, use of oils and grease, lamp filling, sand drying, defective wiring, &c. 2500 w. St Ry Rev—Dec. 15, 1905. No. 73777 C.

Freight Haulage.

Cost of Freight by Electric Haulage. George E. Walsh. Discusses the carrying of freight by interurban electric lines, giving reports from various lines. 2000 w. Elec, N Y—Dec. 6, 1905. No. 73547.

Interurban.

A Desirable Car for Interurban Service. P. J. Mitten. Read before the Indiana Elec. Ry. Assn. Gives the writer's views, and abstract of discussion. 3500 w. St Ry Jour—Dec. 23, 1905. No. 74004 C.

The Dayton & Muncie Electric Railway. Particulars in regard to this recently completed line, with illustrated detailed description of its stations, equipment, rolling-stock, &c. 3000 w. St Ry Jour—Dec. 2, 1905. No. 73519 C.

The Detroit, Flint & Saginaw Railway Co. Illustrated description of the territory served, roadway construction, new power house and equipment. Edward J. Hunt. 2500 w. St Ry Rev—Dec. 15, 1905. No. 73776 C.

Paris.

The Crossing of the Seine by the Metropolitan Railway (Traversée de la Seine par la Ligne Métropolitaine). A. Dumas. Describing the construction of the tunnel under the Seine for the North and South transversal of the Paris Metropolitan railway. 3000 w. 1 plate. Génie Civil—Dec. 2, 1905. No. 73813 D.

Philadelphia.

The Electric Tramways of Philadelphia (Les Tramways Electriques de Philadelphie). P. Ayné. An illustrated description of the electric street and suburban railways of Philadelphia, from a French point of view. 3000 w. Génie Civil—Nov. 25, 1905. No. 73811 D.

Railway Motors.

See Electrical Engineering, Motors.

Singapore.

A Brtish Enterprise in the Far East. An illustrated description of the electric tramways in Singapore. 2200 w. Tram & Ry Wld—Dec. 7, 1905. No. 73971 B.

Single-Phase.

A Short Single-Phase Railway on Long Island. Illustrated description of a road that has been in service for the past two months to convey passengers from Sea Cliff and Glen Cove stations to neighboring steamboat landings on Long Island Sound. 2000 w. St Ry Jour—Dec. 16, 1905. No. 73791 C.

Single Phase Motors for Tramways (Einphasen - Wechselstrom - Betrieb auf Strassenbahnen). E. C. Zehme. A detailed description of the system under test in Paris by the French Thomson-Houston Company. 2000 w. Elektrotech Zeitschr —Dec. 7, 1905. No. 73857 B.

Single-Phase v. Continuous Current for Traction Purposes. Editorial discussion of the merits of a well-designed single-phase system as compared with the continuous current. 2000 w. Engng—Nov. 24, 1905. No. 73602 A.

The Single-Phase Alternating and the Direct Current Systems. A letter from Mr. George Westinghouse setting forth the advantages of the single-phase alternating system, and giving also letters to President Newman of the N. Y. C. R. R. from Mr. Westinghouse, and to Mr. E. M. Herr, from B. G. Lamine. 5200 w. R R Gaz—Vol. XXXIX., No. 25. No. 74011.

Subway.

The New Philadelphia Subway. J. A. Stewart. An illustrated outline of the subway scheme, with the general plan of construction. 1800 w. Sci Am—Dec. 23, 1905. No. 73984.

The Opening of the Philadelphia Subway. An illustrated account of the opening of the first section of this subway, describing the construction. 1800 w. St Ry Jour—Dec. 23, 1905. No. 74002 C.

Telpherage.

The Transmission of Messages by High-Speed Electric Carriers (Le Transport des Correspondances à Très Grande Vitesse par Chariots Electriques Automoleurs). A. Bidault des Chaumes. Describing a scheme for electric-telpherage, for carrying letters and packages. 1500 w. 1 plate. Génie Civil—Nov. 18, 1905. No. 73810 D.

Underground.

An Electric Underground Freight Railway System. Frank C. Perkins. Illustrates and describes details of track and trolley construction in the Chicago subway. 2000 w. Mod Mach—Dec., 1905. No. 73697.

We supply copies of these articles. See page 799.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe,U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.